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DOUBLE NUMBER

NATURAL HISTORY

VOL. XX · SEPT.-OCT. 1920 · No. 4

IN SEARCH
OF THE MOST ANCIENT MAN
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JOURNAL OF THE AMERICAN
MUSEUM OF NATURAL HISTORY

INVERTEBRATE ZOOLOGY · ANTHROPOLOGY · PHYSIOLOGY · EDUCATION

GEOLOGY · MINERALOGY · PALAEONTOLOGY · MAMMALOGY · ORNITHOLOGY

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The American Museum of Natural History

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THE AMERICAN MUSEUM OF NATURAL HISTORY

MEMBERSHIP

For the enrichment of its collections, for scientific research and exploration, and for publications, the American Museum of Natural History is dependent wholly upon membership fees and the generosity of friends. More than 5300 friends are now enrolled who are thus supporting the work of the Museum. The various classes of membership are:

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WHERE THE MONGOLIAN BIGHORN SHEEP ARE FOUND

One of the expedition's hunters looking for sheep in the valleys and on the uplands of the rugged mountains of north Shansi Province, China. Here was collected the group of sheep for the hall of Asiatic life of the American Museum

NATURAL HISTORY

VOLUME XX SEPTEMBER-OCTOBER, 1920 NUMBER 4

New Expedition to Central Asia

TO THE EARTH'S MOST ANCIENT CENTER OF HUMAN DISPERSAL

By ROY CHAPMAN ANDREWS

Associate Curator of Mammals of the Eastern Hemisphere, American Museum of Natural History, and Leader of that institution's First and Second Asiatic Zoölogical expeditions

THE American Museum's Zoölogical Expedition to Mongolia described on pages 356 to 373 of this magazine, together with the First Asiatic Zoölogical Expedition to Yunnan in 1916–17, yielded such valuable scientific collections that it has been decided to conduct further work in Asia, along much broader lines. The Third Asiatic Expedition will extend its researches into the fields of palæontology, archæology, and anthropology, directing its attention mainly to the problem of the origin and development of primitive man.

"All authorities are today agreed in placing the center of dispersal of the human race in Asia," says Dr. W. D. Matthew in an important paper entitled "Climate and Evolution."[1] "Its more exact location may be differently interpreted, but the consensus of modern opinion would place it probably in or about the great plateau of central Asia. In this region, now barren and sparsely inhabited, are the remains of civilizations perhaps more ancient than any of which we have record. Immediately around its borders lie the regions of the earliest recorded civilizations,—of Chaldea, Asia Minor, and Egypt to the westward, of India to the south, of China to the east. From this region came the successive invasions which overflowed Europe in prehistoric, classical, and mediæval times, each tribe pressing on the borders of those beyond it and in its turn being pressed on from behind. The whole history of India is similar,—of successive invasions pouring down from the north. In the Chinese Empire, the invasions come from the west. In North America, the course of migration was from Alaska, spreading fan-wise to the south and southeast and continuing down along the flanks of the Cordilleras to the farthest extremity of South America. . . ."

Moreover, there is strong reason to believe that central Asia was the center of distribution for many of the mammals whose descendants are found living at present in other parts of the world. For instance, the moose, the wapiti or elk, the bighorn sheep, the so-called mountain goat, and the caribou which sportsmen are hunting in America today, are undoubtedly of Asiatic origin. I have shot species nearly related to every one of these animals in China, Mongolia, or on the borders of Tibet.

The wanderings of primitive tribes doubtless were influenced by many different causes, but, as these peoples were primarily hunters, one of the

[1] *Annals of the New York Academy of Sciences*, Vol. XXIV, pp. 209–10.

HEAD OF THE WORLD'S RECORD NORTH CHINA BIGHORN SHEEP

This species, *Ovis commosa*, is one of the group of Asiatic bighorn sheep which are known to the Mongols as "argali." This particular species, which will soon be extinct, is found in the northern mountains of north Shansi and along the southern Mongolian frontier. The great ram will form the central figure of the group which will be prepared for the new hall of Asiatic life in the American Museum

THE HOME OF THE BIGHORN SHEEP

The sheep feed in the valleys shown here and also on the uplands farther to the west. When disturbed, they cross into the rough peaks and are exceedingly difficult to find. The mountains at these places reach an altitude of 7000 feet. The record sheep was killed on one of the ridges shown in the left center of the photograph. This view will be used as part of the background for the Mongolian bighorn group in the American Museum

Roy Chapman Andrews, leader of the Second Asiatic Zoölogical Expedition which has recently returned, on his pony "Kublai Khan" with the fleet-footed antelope as trophy of the chase. Mongol ponies are about the size of our western bronchos and are extremely strong and hardy. They will travel from forty to sixty miles a day without undue fatigue; also, they are fed no grain either in winter or summer, and find their entire food upon the grass of the plains. During the winter they grow a coat of hair five or six inches in length and resemble grizzly bears almost more than ponies. "Kublai Khan" was a very remarkable animal. He learned in a short time exactly how to do his part in hunting antelope and he enjoyed the sport keenly. His intelligence and faithfulness made him one of the most important members of the Asiatic expedition

most important influences must have been the movements of the game upon which they depended for food and skins. Therefore, the study of the early human race is, necessarily, closely connected with and dependent upon a knowledge of the Asiatic mammalian life and its distribution.

Although the importance of this region long has been recognized, *no systematic correlated study on a large scale along various branches of science ever has been attempted, and there is no similar area of the inhabited surface of the earth about which so little is known.* Studies in the zoölogy, botany, and geology of Asia have been carried on from time to time by sporadic expeditions, but without exception these have been confined to special investigations of a given subject.

The fossil history of eastern and central Asia practically is unknown. In North and South America, Europe, and Africa, extensive palæontological work has been carried on for years. This has given to the world the magnificent collections in the great museums of America and Europe and has formed the basis for reconstruction of the earth's history and its inhabitants hundreds of thousands and even millions of years ago. *Knowledge of the fossils of eastern Asia rests almost entirely upon the report on a small collection of teeth and fragmentary bones purchased in the medicine shops of Tientsin and described by a German named Schlosser.*

Material of this sort is of considerable value to the Chinese because they believe the fossils have wonderful me-

dicinal qualities. These fossils are known as "dragon's bones," and whenever a fossil-yielding locality has been found, it is carefully concealed. Nevertheless, during the last three years, Dr. J. G. Andersson, mining adviser to the Chinese Republic, has been carrying on investigations on behalf of Swedish institutions and has made some remarkable discoveries. Dr. Andersson is virtually the first scientist who has ever collected fossils, personally, in China.

In archæology and anthropology our knowledge is well-nigh as deficient as in palæontology. But very little work has been done upon the remains left by pre-Chinese tribes or upon the living aboriginal inhabitants of eastern and central Asia. Accurate conclusions as to the migrations of primitive peoples and the origin and relationships of the civilized nations of the world can never be reached until a careful study of the aboriginal tribes of Asia has been made. It is of course impossible to predict whether primitive human remains ever will be found, but in such an untouched area, results of great scientific importance and popular interest will certainly be achieved.

Although there are no vast unexplored areas of Asia existing today, many comparatively large isolated regions have never been visited by white men. It is safe to say that no countries of the earth have been so inadequately and incorrectly mapped as central Asia and even large parts of such relatively accessible countries as China.

There are many reasons why this region has remained scientifically unexplored for so long a time. It is remote and difficult of access, consequently the cost of conducting work on a large scale is enormous. Moreover, the country itself and its inhabitants present unusual obstacles to scientific research. Not only are there great intersecting mountain chains, waterless deserts, and treeless plains, but in many parts the climate is too cold for effective work in winter. In some places the natives are exceedingly suspicious of foreigners, and religious superstitions handicap research as well as make it decidedly dangerous.

It can readily be seen that operations on an extensive scale require not only considerable preliminary study of the unusual conditions existing, but also strong financial support if they are to be successful. During the last ten years the American Museum of Natural History has carried on work along zoölogical lines in various parts of the Orient with the purpose of ultimately conducting investigations on an extensive scale. Its first and second Asiatic expeditions served to familiarize us with the conditions to be met and to pave the way for future work—besides bringing to the American Museum of Natural History the important zoölogical collections which form a nucleus for study and exhibition in the proposed hall of Asiatic life.

Because of the position which Asia occupies as a center of mammalian dispersal the establishment of an Asiatic hall in any museum which aims to consider the development of natural history as a whole, is of the foremost importance. In its great plan for the future, the American Museum of Natural History has incorporated such a hall. This will have not only an exhibition of mammals, but will also take on a truly faunistic character. In other words, the exhibits in the hall will be a synopsis of the life of Asia, past and present. The basis will be an exhibition of groups with painted backgrounds which will be so selected as to have a definite geographical and botanical as well as a zoölogical value. The high steppes of the Tibetan Plateau, the sandy wastes of the Gobi Desert, the snow-covered peaks of the Himalaya Mountains, the dense forests of the Malayan Peninsula, and the semitropical jungles of southern China

will be shown, each with its attendant natural history. Thus the great lesson of the geographical and climatic factors that have controlled the distribution and development of life can be taught in an objective way. In addition there will be systematic collections of the most characteristic birds, mammals, reptiles, and batrachians. In the same hall as much as possible of the palæontological history will be shown in order to make the story complete.

In the consideration of plans to provide material for the new hall and to carry on scientific work along broad lines, attention was immediately directed by President Henry Fairfield Osborn, of the American Museum, to the American Asiatic Association and to the magazine *Asia* as being the most representative and effective organs in America for the diffusion of knowledge concerning the Orient and the promotion of cordial relations and of mutual understanding between the countries of the Far East and the United States. Accordingly the American Asiatic Association and *Asia* were invited to coöperate with the American Museum in financing the new expedition. At a meeting of the Executive Committee of the American Asiatic Association on June 14, a resolution was adopted unanimously endorsing the plan and pledging its support.

The work will be carried on under the name of "The Third Asiatic Expedition of the American Museum of Natural History, in Coöperation with the American Asiatic Association and *Asia* Magazine."

There is a very real desire on the part of the sponsors for the expedition to make it a factor in the development of the educational life of the Chinese Republic. China has no national institution wherein natural history objects can be studied and exhibited by modern methods and where the scientific work of her own people can be encouraged and directed.

The Western world has come to regard China as negligible from the standpoint of general scientific research. This condition has developed principally because there is no central institution in China which can become a focus for the efforts of her trained men. The gratifying results which already have been attendant upon the efforts of the Rockefeller Foundation in the teaching of medical science to the Chinese show what progress can be expected when similar aid is given along other branches of science.

The sponsors of the expedition, therefore, have decided to invite the Chinese government to coöperate with it in carrying on its work in the Orient. They will be invited to delegate to the expedition certain men who have already had preliminary instruction in various branches of science; these men while in the field will receive training in the modern methods of scientific exploration and study under the best specialists of the world.

When the expedition has been completed, its sponsors will agree to deposit in Peking a duplicate set, in so far as it is possible, of the collections obtained, which will form the basis of a "Chinese Museum of Natural History."

The proposed institution will then have a splendid nucleus of specimens for exhibition and study and the work will be carried on by a staff of Chinese who have received the best training possible. It will remain for the Chinese government to set aside a suitable building where the collections can be arranged for exhibition and study.

Moreover, if in the future the Chinese government wishes to send selected men to New York, the American Museum will undertake to furnish them opportunities for a thorough training in the various branches of museum work and modern methods of exhibition. In short, the American Museum will act as sponsor for the Chinese institution and endeavor to

foster its growth and development in any way within its power.

If the Chinese government accepts our assistance in establishing such an institution, it will certainly become more than a "museum of natural history" in the strict sense. There are in China splendid remains of great archæological and historical value, not only to China but also to the entire world, which are being ruined irreparably by neglect and vandalism. Sporadic attempts have been made by various foreigners to arouse interest in the protection of these splendid monuments, which are among the most glorious relics of China's history, but they all have died a natural death through lack of a practical working basis. If the proposed museum is established under governmental auspices, a natural result will be the inauguration of an archæological survey having for its especial object the care and protection of these antiquities.

It is proposed to carry on the field work of the Third Asiatic Expedition for a period of five years. Headquarters will be established in Peking, from which the various parties will work in the interior of China, central Asia, Manchuria, and Kamchatka. The estimated cost of the expedition will be $250,000, or $50,000 annually for a period of five years. Up to the present time one half of this amount has been guaranteed. Besides the contributions of its sponsors, its inauguration has been made possible by the generous subscriptions of Mrs. Willard Straight, Messrs. J. P. Morgan, W. Averill Harriman, Childs Frick, George F. Baker, and Mr. and Mrs. Charles L. Bernheimer.

It is hoped that the remaining funds which are necessary if the work is to be carried on in the broad way which will make it most effective, will be subscribed before the expedition is ready to leave for the field.

The results of the Third Asiatic Expedition will be published in a series of scientific volumes which it is hoped will become the standard works on the natural history of central and eastern Asia for many years to come. Popular books, telling of the work and discoveries in nontechnical language and in a readable way, also will be prepared, and the progress and travels of the expedition will be presented in the pages of *Asia,* and in the official organ of the American-Museum, NATURAL HISTORY.

Pictorially, there is an opportunity for splendid educational work of a highly interesting and important character. The plan is to show in motion pictures the entire history of the expedition. Not only will these films be exhibited in weekly serials throughout the United States, but complete stories of the life of remote tribes will also be prepared to show to the people of America the strange natives in these little-known corners of the world.

Assistants on the Second Asiatic Zoölogical Expedition bringing in roebuck killed in north Shansi Province, China, where the wapiti were collected

In Mongolia and North China[1]

By ROY CHAPMAN ANDREWS

WHEN I left Peking in late August of 1918 to cross Mongolia, I knew that I was to go by motor car. But somehow the very names "Mongolia" and "Gobi Desert" brought such a vivid picture of the days of Kublai Khan and ancient Cathay that my mind refused to admit the thought of automobiles. Not even on the railway when I was being borne swiftly toward Kalgan and saw the lines of laden camels plodding along the paved road beside the train, or when we puffed slowly through the famous Nankou Pass beside that wonder of all the world, the Great Wall, that winds like an enormous serpent over ridge after ridge of mountains, was my dream picture of mysterious Mongolia dispelled. I had seen all of this before and had accepted it as one accepts the motor cars beside the splendid walls of old Peking. It was all too near and the railroad had made it commonplace. But Mongolia! That was different. One could not go there in a roaring train. I had beside me the same old rifle and sleeping bag that had been carried across the mountains of far Yunnan, along the Tibetan frontier and through the fever-stricken jungles of the Burma frontier. Somehow these companions of forest and mountain trails did much to keep me in a blissful state of unpreparedness for the destruction of all my dream castles.

My first trip was with Mr. Charles L. Coltman, who was accompanied by his wife. His object was to visit his trading station at Urga, the capital of Mongolia, which was our destination; mine was to make a reconnaissance for zoölogical work the following summer. We left Kalgan early in the morning on horseback, for the cars were at a mission station forty miles away. About ten miles from Kalgan we began on foot the long climb up the pass which gives entrance to the great plateau. I kept my eyes steadily on the pony's heels until we reached a broad flat terrace halfway up the pass. Then I swung about that I might have, all at once, the view which lay below us. It justified my highest hopes. Miles and miles of rolling hills stretched away to where the far horizon met the Shansi Mountains. It was a desolate country which I saw, for every wave in this vast land sea was cut and slashed by the knives of wind and frost and rain and lay in a chaotic mass of gaping wounds,—cañons, ravines, and gullies painted in rainbow colors, crossing and cutting one another at fantastic angles as far as the eye could reach. When a few moments later we reached the summit of the pass I felt that no spot I had ever visited satisfied my preconception quite so thoroughly. Behind and below us lay that stupendous relief map of ravines and cañons. In front was a limitless stretch of undulating plain. I knew then that I really stood upon the edge of the greatest plateau in all the world and that it could be only Mongolia.

We spent the night at the mission station and at daylight packed the cars. Bed rolls and cans of gasoline were tied on the running boards and every corner was filled with food. For thirty miles we drove over a fair road bordered by fields of yellowing grain.

[1] Illustrations for this and the preceding article from photographs by Yvette Borup Andrews.

THE AUTHOR IN THE MONGOLIAN FOREST

The Mongolian roebuck is a species larger than any of the roe deer found in Europe or Asia. It has habits almost identical with those of our Virginia deer in America

A caravan of camels watering at a well in the desert of Gobi. The presence of the expedition's automobile, also at the well for water, afforded a striking contrast in methods of transportation

This species of wapiti or elk of northern China will soon be extinct. It is closely related to the wapiti of America. For many years the belief was entertained that wapiti were peculiar to the forests of North America, but in recent times they have been discovered in various parts of north and central Asia

We were seldom out of sight of mud-walled huts and tiny Chinese villages. Chinese peddlers passed our cars carrying baskets of fruit or of trinkets for the women. Chinese farmers stopped to gaze at us as we bounded over the ruts; in fact, it was all Chinese, although we were really in Mongolia. I was eager to see Mongols, to register the first impressions of a people of whom I had thought so much—but the blue-coated Chinaman was ubiquitous.

For seventy miles from Kalgan it is all the same—Chinese everywhere. The Great Wall was built to keep the Mongols out. By the same token it should have kept the Chinese in, but the rolling grassy sea of the vast plateau was too strong a temptation for the Chinese farmer. Encouraged by his own government, which knows the value of just such peaceful penetration, he pushes forward the lines of cultivation a dozen miles or so for every year. As a result, the grassy hills have given place to fields of wheat, oats, millet, buckwheat, and potatoes.

Beyond the area of agriculture we came to a region of long rich grass where water is by no means scarce. Flocks of goats and fat-tailed sheep drifted up the valleys, and now and then a herd of cattle massed themselves in moving patches on the hillsides; but they are only a fraction of the numbers which this land could easily support.

When we came to our first Mongol village, I jumped out of the car to take a photograph but scrambled in again almost as quickly, for as soon as the motor had stopped, a dozen dogs dashed from the houses snarling and barking like a pack of wolves. They are huge brutes, these Mongol dogs, and as fierce as they are big. Every family and every caravan owns one or more. We learned very soon never to approach a Mongol encampment on foot. The natural ferocity of the dogs is probably accentuated by the Mongol custom of throwing out their dead to be devoured by them, as well as by wolves and birds. This diet of human flesh must have a marked effect upon the animals which are naturally savage, and they are a very real danger to life. My wife and I had the narrowest escape from death which we have ever had in all our travels from these same dogs, and more than once when we were on horseback we were attacked by the snarling brutes.

A Mongol village is as unlike a Chinese settlement as it well can be. Instead of closely packed mud houses we found the Mongol habitation to be a circular latticed framework covered with felt, and with a cone-shaped roof. The yurt, as it is called, is perfectly adapted to the Mongolians and their life. In the winter a stove is placed in the center and the house is dry and warm. In the summer the felt covering is sometimes replaced by canvas which can be lifted on any side to allow free passage of the air. When it is time for the semiannual migration to new grazing grounds, the yurt is quickly dismantled, the framework collapsed, and the house packed on camels or carts.

At Panj-Kiang, the first telegraph station, we came to the "edge" of the desert. In reality, however, there is no edge to this part of the Gobi, for the grasslands, both on the south and the north, merge so imperceptibly into the more arid central region, that it is difficult to see where the Gobi really begins or ends. As a matter of fact there is no desert at all, in the popular sense of the word, between Kalgan and Urga. I was always looking for it, but never found it. Even in the most arid part in summer it resembles a rolling meadowland. When one looks more closely, one sees that the vegetation is mostly "Gobi sagebrush" and short bunch grass growing from a soil

of fine gravel. Farther to the west the Gobi becomes a real desert, which Sir Francis Younghusband says is the most desolate waste of sand and gravel that he has ever seen.

There was no lack of bird life along the way. Thousands of mallard ducks and teal were in the ponds which we passed before we reached Panj-Kiang. Golden plover were often frightened by the car from their dust baths in the road, and crested lapwings flashed across the prairie like sudden storms of autumn leaves. Huge golden eagles and enormous ravens made tempting targets on the telegraph poles, and there were cranes in thousands.

The demoiselle crane, one of the most beautiful species of this splendid family, we found all the way across the Gobi; it comes to Mongolia to raise its young. Twice in the summer we found its nest—or rather eggs, for it makes no nest at all. The spotted brown eggs are laid quite openly on the ground and their coloration is their best concealment. In late June we caught two of the young just hatched. They were ridiculous little things, all legs and neck, with yellow crowns which made them appear entirely bald. It seemed hardly possible that they could grow into the graceful birds which wheeled in ever widening circles above our heads, their notes coming down to us faintly like the voices of happy children.

Now and then we left the road to shoot a bustard. These strange birds, relatives of the cranes and as large as turkeys, are always shy. Their enormous size makes them conspicuous on the plains, but they do not attempt concealment, depending upon their marvelous sight to protect them from enemies. We could seldom approach nearer than within two hundred yards and even at that distance they are not easy targets. Coltman shot one that weighed thirty-five pounds on the scales in Urga. It was the largest male bustard I have ever seen and had the bare throat patches of brilliant blue and the long side whiskers splendidly developed. Later I killed another, almost as large, which I had watched for half an hour through my field glasses. The female had flown away but the male strutted about with drooping wings and spread tail exactly like a turkey cock.

Just beyond Panj-Kiang we saw the first antelope. There always seemed to be antelope on the Panj-Kiang plain and many of them. We were comfortably rolling along on a stretch of good road when Mrs. Coltman, whose eyes are especially keen, excitedly pointed to a hillside on the right not a hundred yards from the trail. At first we saw nothing but the yellow grass. Then the whole hill seemed to be in motion. A moment later I began to distinguish heads and legs and to realize that it was an enormous herd of antelope closely packed together, restlessly watching us. Our rifles were out in an instant, and Coltman opened the throttle. The antelope were five or six hundred yards away and as the car leaped forward they strung out in single file across the plain. We left the road at once and headed diagonally toward them. For some strange reason when a horse or a car runs parallel with a herd of antelope, the animals swing in a complete semicircle and cross in front of the pursuers. Whether they think they are being cut off from some more desirable means of escape, I cannot say, but the fact remains that with the open plain on every side, they always try to "cross your bows."

I shall never forget the sight of those magnificent animals streaming over the desert. There were at least a thousand of them and their yellow bodies seemed fairly to skim the earth. I was shouting in excitement but Coltman said, "They are not running yet. Wait until we begin to shoot." I could

Mongol herdsmen carrying the lasso which consists of a twenty-foot pole with a sliding noose at the end. The natives handle such a lasso very expertly

A Mongolian water carrier with his camel in the Gobi Desert.—The wells are sometimes fifty or sixty miles apart and caravans carry water for their personal need in casks (such as are shown supported on the animal). The camels, when on the trail, travel four or five days, if necessary, without drinking

A Mongol woman looking at her portrait in a copy of an American magazine. This picture and the one opposite present two complicated methods of dressing the hair in Mongolia

scarcely believe my eyes when I saw the speedometer trembling at thirty-five miles an hour, for the animals were leaving us almost as though we were standing still. But then their fatal habit began to assert itself and the long column bent gradually in our direction. Coltman widened the arc of the circle and held the throttle open as far as it would go. Our speed increased to forty miles and the car began to gain because the antelope were running almost across our course. They were about two hundred yards away when Coltman shut off the gas and jammed both brakes, but before the car stopped they had gained another hundred yards. I leaped over a pile of bedding and as soon as my feet were on the ground came into action with the .250 Savage high power. Coltman's .30 Mauser was already spitting fire across the wind shield from the front seat, and at his second shot an antelope dropped like lead. My first two bullets struck the dirt far behind the rearmost animal, but the third caught a full-grown female in the side and it plunged forward into the grass.

I realized then what Coltman meant when he said that the antelope had not begun to run. At the first shot every animal in the herd seemed to flatten itself and settle to its work. Their legs became merely a blur like the wings of an electric fan and I wondered if even a bullet could catch them.

When the excitement was over, I began to understand the significance of what we had seen. It was slowly borne in upon me that our car had been going, by the speedometer, at forty miles an hour and that *the antelope were actually beating us.* I knew that they must have been traveling much faster than forty miles, for they were running in a half circle while we were going straight ahead. It was an amazing discovery; I had never dreamed that any living animal could run so fast.

It was a discovery which would be of considerable importance, too, in the investigations which Professor Henry Fairfield Osborn, of the American Museum, has been carrying on as to the relation of speed to limb structure in various groups of animals. I determined with Mr. Coltman's help to get some real facts in the case—data upon which we could rely. There was an opportunity only to begin this study on the first trip but we carried it further the following year. Time after time, as we tore madly after the antelope which were proceeding singly or in herds, I kept my eyes upon the speedometer, and I feel confident that our observations can be relied upon. We demonstrated beyond a doubt that the Mongolian antelope (*Gazella gutturosa*) can reach a speed of sixty miles an hour. This is probably the maximum, and after a short dash the animals must slow down to about fifty miles; a short distance more and they drop to forty or thirty-five miles, which they seem able to continue almost indefinitely.

The antelope never ran faster than

Wife of one of the expedition's hunters looking at pictures of Urga in a copy of an American magazine. It was the first time she had ever seen a photograph or its half-tone reproduction

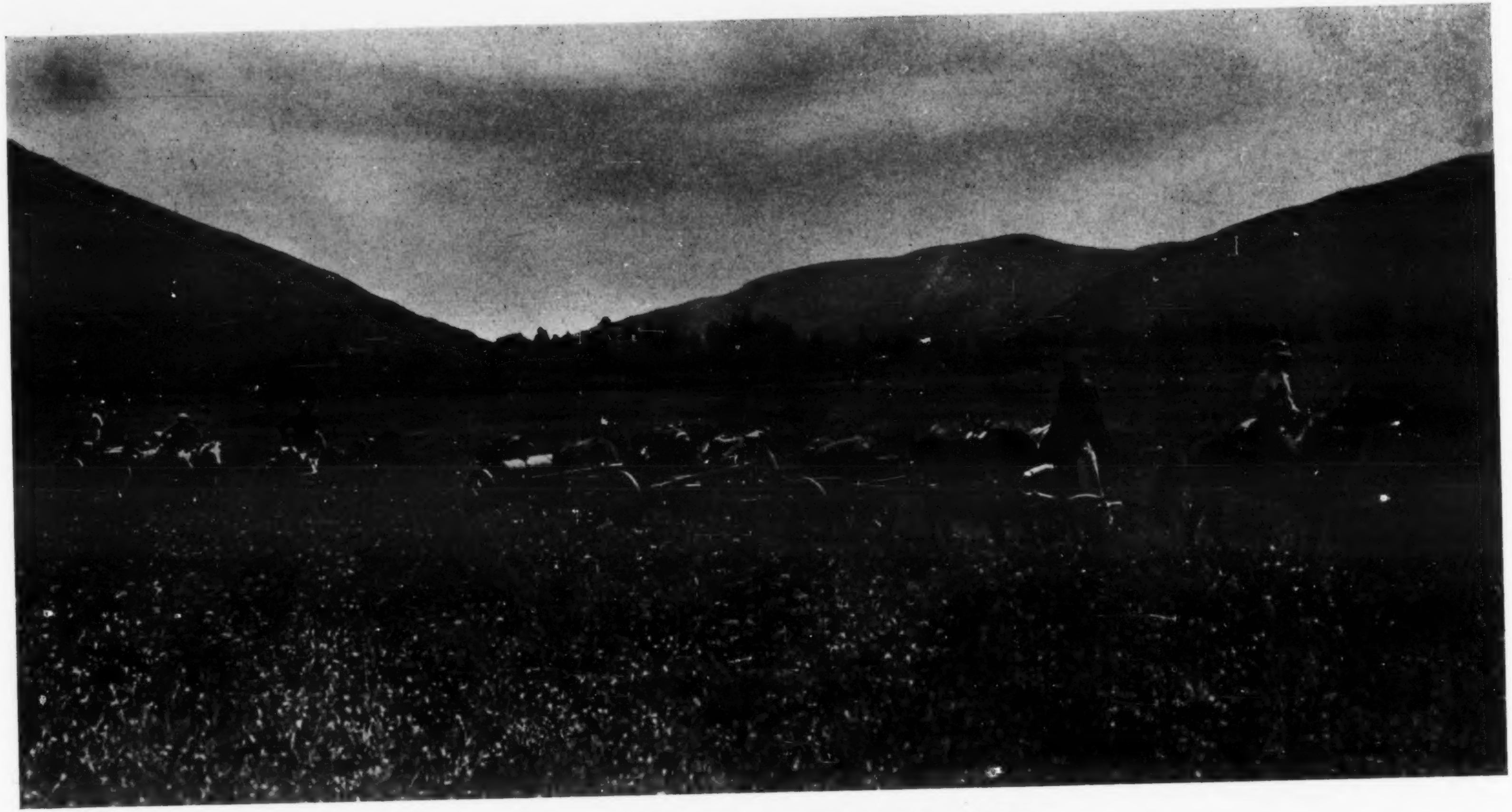
was necessary to keep well away from us. As we opened the throttle of the car they too increased their speed. It was only when we began to shoot and they became thoroughly frightened that they showed what they could do. I remember especially one fine buck which gave us an exhibition of really high class running. It started almost opposite to us, when we were on a stretch of splendid road, and it jogged comfortably along at thirty-five miles an hour. Our car was running at the same speed, but the antelope decided to cross in front of us and pressed its "accelerator" a little. Coltman also touched ours and the car jumped to forty miles. The antelope seemed very much surprised and gave its accelerator another push. Coltman did likewise and the speedometer reached forty-five miles. That was about enough for us and we held our speed. The antelope drew ahead on a long curve and swung across in front of the car. It had beaten us by one hundred yards.

The antelope have developed this great speed, of course, to protect them from the wolves which range the plains. We determined definitely that a wolf when running for its life cannot do better than thirty-five miles an hour. With antelope that can run sixty miles an hour a wolf has little chance, unless he catches them unawares or finds the newly born young. To avoid just this the antelope are careful to stay well out on the plains where there are no rocks or hills which could conceal a skulking wolf.

Of course our work upon the plains was not conducted from a motor car. In the future we hope to use automobiles, for there are few places in Mongolia where they cannot go, but on this trip we abandoned the cars at Urga and did all our work from horseback with our camp equipment transported in carts. For two and one half months we worked on the plains within a few hundred miles of Urga. Although studying the life history of the antelope and obtaining specimens of them for a group in the new hall of Asiatic life at the American Museum was the most interesting part of the work, nevertheless the plains afforded a productive field for small mammal collecting.

After these delightful months we regretfully turned back toward Urga. Our summer was to be divided between the plains on the south and the forests to the north of the sacred city, and the first half of the work had been completed. Urga is an ideal place for a base camp, because it is at the junction of the Siberian and central Asian life zones. The former is sharply delineated by the limit of the trees, and on the south the central Asian zone has a plains fauna totally unlike the animals of the forests.

We remained only three days in the capital. Until then Mongolia, to us, had meant only the Gobi Desert and the boundless rolling plains. When we set our faces northward we found it was also a land of mountains and rivers, of somber forests and gorgeous flowers. We had learned that the Terelche



THROUGH MONGOLIA'S FLOWER-GROWN VALLEYS

The Second Asiatic Expedition on the way into the woods north of Urga. For the first half of the summer the expedition worked on the plains, and from the first of August until October it carried on collecting in the forests which stretch away in an unbroken line far beyond the Siberian frontier. The first three carts are drawn by Tibetan yaks, which are used as draft animals in Mongolia. In the foreground may be seen a few of the many flowers forming a brilliant carpet on the hills and valleys of northern Mongolia during the summer. There are acres upon acres of daisies, poppies, roses, and many other species

THE CARAVAN

The expedition crossing the Terelche River. — The carts are drawn by Tibetan yaks and ponies. The yaks, although very slow, can pull enormous loads. The rivers of northern Mongolia are sometimes very difficult to cross, for a few hours' downpour turns them into raging torrents

AT THE END OF THE LONG TRAIL ACROSS MONGOLIA

Camels arriving in the cultivated areas of China about sixty miles from Kalgan.—Practically all goods during the winter are transported across the desert by camels. In the summer ox- and pony-carts assume the transportation while the camels are resting and accumulating strength for the winter's work. Ox-carts take ninety days to cross Mongolia between Kalgan and Urga, camels require forty days, automobiles go in three and one half days, and aëroplanes will make the journey in six hours

A SOLITARY CAMP ON THE GOBI DESERT

A Mongol and his wife with a single camel are making their way across the plains and desert from Kalgan to Urga. They have stopped here to cook their dinner, and later will roll up in their fur coats and go to sleep under the stars. It rains but seldom in the desert and a tent is by no means necessary for comfort

River would offer a fruitful collecting ground. It was only forty miles from Urga, and the first day's trip was a delight. We traveled northward up a branch valley enclosed by forested hills and carpeted with flowers. Never had we seen such flowers! Acre after acre of bluebells, forget-me-nots, daisies, buttercups, and cowslips, converted the entire valley into a vast "old-fashioned garden," radiantly beautiful.

On the second morning, however, we awoke to a cloud-hung sky and floods of rain, instead of to golden sunshine. No one wished to break camp in the icy deluge, but between us and the Terelche River were three marshes which were bad enough in dry weather; a few hours of rain would make them impassable, perhaps for weeks. My wife and I look back upon that day and the next as among our few real hardships. After eight hours of killing work, wet to the skin and almost frozen, we crossed the first dangerous swamp and reached the summit of the mountain. Then the cart with our most valuable possessions plunged off the road on a sharp descent and crashed into the forest below. Chen, one of the Chinese taxidermists, and I escaped death by a miracle, and the other taxidermist, who was safe and sound, promptly had hysterics. It was discouraging, to say the least. We camped in the gathering darkness on a forty-five degree slope in mud twelve inches deep. Next day we gathered up our scattered belongings, repaired the cart, and reached the river.

We had a letter from a Mongol duke to a famous old hunter named Tserin Dorchy. All Mongols are independent, but Tserin Dorchy is an extreme in every way. He rules like an autocrat the half dozen families in the valley. What he commands is executed without a question. I was anxious that the expedition should move promptly and announced that we would start the day after our arrival. "No," said he, "we will go two days from now." Argument was of no avail. So far as he was concerned the matter was closed. When it came to arranging wages he stated his terms, which were exorbitant. I could accept them or not as I pleased. He would not reduce his demands by a single copper. Nevertheless, he was an excellent hunter, and we came to be good friends.

I made a base camp in the valley not far from his yurt and while the work on small mammals was carried on by the Chinese taxidermists, my wife and I hunted with the Mongols for larger game. On these trips our equipment consisted only of sleeping bags and such food as could be carried on our horses. It was a time when living close to nature was really necessary. By arranging a bit of canvas over the low branches of a tree we prepared a shelter for ourselves, and then made a second for the hunters. We became typical nomads, spending a day or two in some secluded valley only to move again to other hunting grounds. For the time, we were Mongols in all essentials. The primitive instincts, which lie just below the surface in us all, responded to the subtle lure of nature, and without an effort we slipped into the care-free life of these children of the woods and plains. We slept at night under starlit skies; the first gray light of dawn found us stealing through the dew-soaked grass on the trail of elk, moose, or bear; and when the sun was high, like animals we spent the hours in sleep, until the lengthening shadows sent us out again on the evening hunt.

For three months we worked near the Terelche River, and came to know every mountain and valley, every stream and marsh, as New Yorkers know their city. Our boxes held nearly one thousand specimens when we left the forest, all of which were unlike those we had obtained upon the plains. Wood pikas, voles, shrews, mice, and

ON THE GRASSLANDS OF MONGOLIA

A flock of fat-tailed sheep in the valley of the Tola River, one hundred miles west of Urga. This valley furnishes wonderful grazing and is a favorite resort in winter for Mongols. They raise thousands of sheep for the mutton which forms 75 per cent of their food, and the skins which they use for clothing. The possibilities for the production of mutton, beef, wool, and hides seem limitless on the northern and southern grasslands of Mongolia

A wrestling contest in the field meet of the Terelche Valley.—The Mongolian wrestler usually takes hold of his opponent's waistband and endeavors to obtain a fall by sudden heaving

Women of southern Mongolia in front of their yurt—the portable felt-covered tent which is the Mongol's home in all parts of the country. Compare the hairdress of red coral and beads which these women of southern Mongolia are wearing, with the remarkable hornlike projections over which the hair is dressed by the women of the north (see pp. 362 and 363)

squirrels had been caught in traps. To my rifle had fallen bear, roebuck, wild boar, musk deer, moose, and elk. The forests yielded up their treasures as we had dared not hope they would, and we left them with almost as much regret as we had left the plains.

It was late September when we returned to Urga. For a month there had been heavy frosts at night and several storms of snow and hail. We knew that any day might plunge us into winter, and although Mongolia is a paradise in summer, its winters are to be avoided. The temperature sometimes drops to seventy degrees below zero and the bitter winds which sweep across the plains make it one of the coldest spots on earth.

On October first the specimens were started southward on camel back, while we left by motor car. Five days later we were in Peking, and I was greeting the Reverend Harry R. Caldwell, who was to join me for a trip to the northern edge of Shansi Province after the Mongolian bighorn sheep.

Mrs. Andrews feeding a white-maned serow.—This animal was captured when only a few weeks old and became as tame as a domestic goat. Serows are exceptionally rare in zoölogical gardens and there is none on exhibition in America. The expedition desired to bring this specimen to the New York Zoölogical Society, but the Department of Agriculture at Washington could not permit the animal to be landed because of restrictions regarding Asiatic cattle diseases. The serow is an intermediate stage between the true goats and the antelopes and is closely related to the so-called Rocky Mountain goat of America

The hunting grounds are only five days' travel from Peking and many foreigners have turned longing eyes toward the mountains which hold the sheep; but the region is infested with brigands, and since Sir Richard Dane, formerly foreign chief inspector of the Salt Revenue, and Mr. Charles Colt-

man had been driven out by the bandits in 1915, the Chinese government had refused to grant passports to foreigners who wished to shoot in that region. The brigands cannot waste cartridges at one dollar each so the animals had been allowed to breed unmolested. Nevertheless, not many sheep are there. They are the last survivors of the great herds which once roamed the mountains of all north China. The technical name of the species is *Ovis commosa,* and it is one of the group of bighorns known to sportsmen by the Mongolian name "argali." In size as well as ancestry these are the grandfathers of all the sheep. The largest ram of our Rocky Mountains is a pygmy compared with a full-grown argali.

The supreme trophy of a sportsman's life is the head of a Mongolian ram, for it can be obtained only by the hardest work. I think it was Rex Beach who said, "Some men can shoot but not climb. Some can climb but not shoot. To get a sheep you must be able to climb and shoot too." For its proposed hall of Asiatic life, the Museum badly needed a group of argali. Moreover, we wanted a ram which would fairly represent the species, and we wanted a very big one.

The brigands did not worry us unduly. Both Mr. Caldwell and I have had considerable experience with Chinese bandits and we feel that they are like animals in that if you do not tease them they will not bite. In their case the "not teasing" implies carrying nothing that they could readily dispose of, especially money. The Chinese Foreign Office did not know, of course, where we were going. Our passports were viséed for Shansi, but had the officials suspected our destination orders would have been issued to prevent us from going into the mountains.

Our plan was to avoid the main roads, and strike off into the hills before the authorities knew where we had gone. The plan was successful and we made our camp at the little village of Wu Shi-tu, where we obtained two Mongolian hunters. I cannot tell in detail of those glorious days in the mountains. The hunt there is a story in itself. Suffice it to say that we were more successful than we had dared to hope. When we returned to Peking, our carts contained a magnificent ram with the world's record head, and six other sheep illustrating the stages of horn growth in a splendid way. Moreover, we had obtained three fine wapiti, representing a species which will soon be extinct in north China. Besides these, we had seventeen roebuck, two gorals, and a large series of hares and smaller mammals.

One other successful trip to the mountains of central Shansi, this time for wild boar, completed the field work of the Second Asiatic Expedition. It only remained to pack the specimens and to transport them to New York. They safely reached the American Museum, not long after we ourselves arrived there, through the assistance of Mr. A. S. Jackson, of Shanghai, passenger agent of the Canadian Pacific Ocean Service. It is useless to gather specimens in the field unless they can be brought to the museum *in perfect condition,* and it was an especial pleasure to find, when the cases were opened, that not a single skin had suffered from the long journey.

Mr. Jackson's aid is only one instance of the cordial coöperation which we received throughout our work in the Orient. The universal courtesy of the Chinese officials and the resident foreigners was delightful, and on the other hand, it was a source of pride to us that we were representatives of the American Museum of Natural History, whose educational work has won recognition throughout the world.

TIBETAN YAKS DOMESTICATED IN NORTHERN MONGOLIA

This great oxlike animal does not occur wild in Mongolia, but numbers have been domesticated and brought to the vicinity of Urga for use in drawing heavy loads. The yak is often interbred with the domestic cattle. These crossbreeds can always be distinguished, however, by the fact that they do not have an extremely bushy tail which is characteristic of the pure-blooded yak and which is well shown in the photograph. The animals make a loud grunting noise, comparable with that of the pig

Social Evolution: A Palæontologist's Viewpoint

By W. D. MATTHEW

Curator of Vertebrate Palæontology, American Museum

IN a recent address a well-known newspaper editor is quoted as saying: "To me the lack of proof of any improvement of the human mind as far back as history goes is the most impressive proof of the creation of the human mind, against the theory of evolution."

This is a brief reference to what may appear to well-informed and fair-minded people a very weighty argument. Especially it might appeal to anyone well versed in history and in classic literature but more superficially acquainted with modern geology and modern evolutionary doctrines. To the palæontologist, on the other hand, evolution appears not as a theory at all but as a general law, a matter of fact and record so far as he deals with it. He is so far saturated with evidence of it, so accustomed to seeing its application to all aspects of life that come under his view, that it seems impossible to believe that a reasonable man could question it any more than the laws of physics and chemistry.

Yet I think that the statement quoted above, in the sense that its author doubtless meant it, is at all events approximately true, however unacceptable the inference he draws from it. So far as my own reading would lead me, it is accurately true. I cannot see that there is any evidence of the improvement of the human intellect in historic time. The Dialogues of Plato appear to be written for minds fully as acute as those of modern students of philosophy. The perceptive and reasoning powers of the writers of the Bible seem to be on a par with those of modern writers. The accumulation of knowledge has of course led to great progress in our acquaintance with facts and the generalizations based on facts. It has involved a still greater progress in material civilization; and these features of progress have been tremendously accelerated by the invention of printing and improvement of means of intercommunication. But in intellectual ability *per se* I cannot see that there is any conclusive evidence of advancement; and certainly, if there is any, it is not great.

There is, however, another aspect of the human mind in which I think there is very clear evidence of progress. This is the moral or ethical as contrasted with the intellectual side. Here, I think, one may see both in precept and in practice, a marked advance, a steady improvement, fairly continuous upon the whole, and resulting in a notable contrast between the standards that we see represented in the writings and actions of early peoples, and those which prevail today. I use the term "moral qualities" in its broadest sense to include all those inhibitions and restraints, those actions and thoughts which prefer the ultimate advantage of the individual to his present advantage, which sacrifice a lesser individual benefit for a greater race benefit, which tend to the development of social life and more elaborate social organization.

Consider the moral standards of the Old Testament as compared with those of today. How would we regard David, "the man after God's own heart"? An able warrior, no doubt, clever, active, well-meaning, magnetic, a good fellow on the whole, but surely something of a weak brother. How would he measure up with Washington, with Lincoln, with William Pitt? "The righteous

man sweareth an oath and keepeth it *even* though it be to his own hindrance." Surely that is not so remarkable in the modern righteous man as to call for special and rather surprised commendation. "An eye for an eye and a tooth for a tooth." Are these the ideals of our modern treatment of criminals? Rather, one would say they are the standards that prevail among the criminal classes themselves.

Or, take the matter of self-control, of the regulation and management of one's daily life and habits. How many of the kings and leaders of olden time were able to withstand prosperity, to refrain from indulgences that shortened their own lives and ruined the prestige of their dynasties in one or two generations? Does not the whole of ancient history leave one with an impression of gorging and feasting without regard for the morrow, of snatching at the pleasures of the moment often at a terrible future cost? Contrast with this the sober regularity of the average civilized man of today, the diligence and abstemiousness of most modern leaders, political or financial. It is useless here to cite examples, but I cannot but be impressed by a marked difference in averages.

Take, again, the matter of courage. How many cowards has the recent war provided? Scarcely here and there an individual among the millions of peaceable citizens who have been drafted into an occupation alien to their habits, desperately uncomfortable and infinitely more trying than the sudden shock of an occasional short combat of a few hours. Yet anything approaching this degree of courage was the rare and highly praised exception in the olden days. Disorderly flight among the vanquished, utter loss of either discipline or resolute resistance after a few hours' unsuccessful fighting, was the common result of ancient battles. Such craven cowardice is almost unknown today, and the spirit that has conquered it is no hardiness or toughness of temper, no carelessness of one's life, but, whether flaunted openly or hidden under a veil of modesty, it is the spirit of self-sacrifice for an ideal, hardly even for national benefit, but rather for the good of humanity and of civilization as each side interprets that good.

In another respect the moral improvement that has taken place is more concretely shown. This lies in the restraints and self-control, the breadth of view and fairness of temperament that enable large groups of men to combine and coöperate in business or politics. The success of such organizations, their practicable size and permanency, are measured by the development of these moral qualities in those who enter into them. The political and commercial history of different peoples shows very clearly what were their capacities for organization; and the far greater size, complexity, and permanency of such organizations today in contrast with the small size of the ancient groups, their loose organization and transitory life, indicate pretty clearly the higher stage of moral standards that we have attained. Read the history of the little peoples of Greece, and see how their short-sighted selfishness, tribal vanity, treachery, and cruelty again and again prevented united action, or destroyed the flimsy unions that were formed. See how the Romans, inferior intellectually, prevailed because of their higher capacity for social organization. Note the endless succession of kaleidoscopic shiftings of the loose administrative organisms of the Eastern empires and even of Egypt, although in the last case they were tied to a fixed spot by the isolated and fertile valley of the Nile which provided the material basis upon which they were founded, and gave a partly real, partly apparent permanency to the succession of governments which controlled it.

Contrast with this the relative permanency of modern civilized nations, whose governments have endured, unchanged in essentials, for many centuries: the huge populations which they control, their complexity of organization, their growing reliance upon the law-abiding instincts of the people, upon justice and equity rather than upon force. See how clearly this is correlated with high standards of civilization, how the forms of good government degenerate into corruption, disorder, and military control, and the larger units break up into smaller and looser organizations when entrusted to the hands of inferior races who lack the higher moral or social standards and practice of modern civilized peoples.

One might cite instances and applications without end, but the above will suffice to illustrate the point I wish to make—that while there is no conclusive evidence of intellectual evolution in the human mind since the dawn of history, there would seem to have been a very considerable moral or social evolution—I use the words interchangeably—during that period.

Now all this is exactly what we should expect on the Darwinian theory. Five thousand years, the most that we can give to such historical records as bear upon the present problem, is too short a time, if measured by the recorded rate of progress in evolution, to produce any perceptible change in the physical structure of man. And his intellect, based as it is upon the physical structure and complexity of his brain, should show a similarly slow rate of change. The specialist distinguishes with difficulty between the skull of an extinct horse of the early Pleistocene and that of its modern descendant. Whether we estimate the length of the Pleistocene at 100,000 years or, as high modern authorities insist, at a million or more, it is obvious that the evolutionary change in this race during five thousand years would be imperceptible. And this is equally true of any other race of mammals of which we have a good evolutionary record. By this measure one would not expect to see any appreciable evolutionary change in the brain and intellect of man since history began. On the contrary, if a marked and obvious improvement in brain or other physical characters had taken place during that time, it would constitute an exceptional case of abnormally rapid evolution, calling for explanation.

On the other hand, the moral qualities may be viewed as partaking rather of the nature of fixed habits, viewpoints, instincts, not directly correlated with the complexity of the physical brain structure, and, like other instincts and habits, much more variable and more rapidly modifiable than the physical structures of the body and functions directly dependent upon them.

Natural selection will seize upon those variations which are most useful for the individual or for the race, and will accumulate them in proportion to the rate at which they can be modified. Obviously the moral qualities of man have for many centuries been at least as important for his social advantage as any intellectual or physical superiorities for his individual advantage. Because of their being more rapidly improvable, the principal advance has been in these qualities. Indeed, I find it difficult, as a palæontologist, to look upon human history as other than a splendid record and display of the operation of natural selection applied to races instead of individuals, and resulting in social, not in individual, evolution. This process of social evolution with its rapid changes leading often to an astonishingly elaborate and perfected organization, is by no means confined to man. It is illustrated again and again, in various stages of its development, throughout the ani-

mal kingdom. The traces of its existence in extinct races are naturally obscure and difficult to decipher; we are dependent upon observation of living animal societies and inferences as to the evolution of their habits.

From observation and comparison of such modern social communities, one may perhaps draw certain conclusions as to the trend and limits of social evolution, and apply them to the future of our own race.

(1) Marked tendency to a progressive uniformity and fixity of type and habits. In the early stages of social development one may observe a considerable flexibility and individual initiative, a greater variation in the action of the individual under given conditions. In the more elaborated types of social life the individuals of each class appear to think, act, and feel alike and to perform their respective duties in a more uniform and automatic way.

(2) Although amazingly precise and elaborate social relations are found among lower animals—insects especially—yet the complexity of the community life appears to be limited in many ways by the intelligence of the individual. None of the higher animals has carried social life to the extremes of precision and exact coördination that we observe among the social insects; in none of them is the individual so far sacrificed for the benefit of the race. Yet the complexity of the social life of the higher animals is in some respects greater—in man it is far more complex.

The ultimate result of social evolution would seem to be a precisely adjusted, uniformly acting organization, working with the automatic accuracy of the complex association of cells of which each individual is composed. The degree of complexity which such an organization can attain before it reaches that precise adjustment depends, as I see it, upon the intelligence of the individual units which compose it.

If this be true, we must conclude that once such a finished social mechanism has been perfected, its further progress must be relatively slow. While up to this stage its evolution has depended upon the modifying and perfecting of the moral or social instincts, henceforth it must depend upon the far slower evolution of a higher physical and intellectual type. From the short perspective of human history this phase of physical and intellectual evolution is so slow as to be negligible. We may fairly say that our present trend of social evolution will tend to advance to a civilization far more complex, far more precise in its adjustment, to continually more uniform group-types of individuals, not appreciably higher in intellect but very much higher in morality; to eliminate more and more completely the criminal, the idle, the selfish individual, the unsocial of every type; and to reach finally the goal of altruistic endeavor. This cannot be reached, however, in a generation; such a mechanism involves much higher standards of morality than now exist in the average man, and requires also the elimination of all who fail to measure up to them. But that this process is going on, and has been going on for some thousands of years, I, who read history in the light of palæontology and evolution, cannot doubt. Nor have I any doubt as to its ultimate outcome, regrettable in some respects, desirable in many others, to the individual who, with growing social instincts, still retains some of the flexibility and impatience of restraint and uniformity that are inherited from his remote forebears of the wild tribes of primitive man. But what will be, will be. We may try to read the future if we will; we cannot alter it.

A DETAIL OF THE NUNNERY AT UXMAL

The stone faces of forgotten gods, placed one above the other in panels of richest ornament, look out from the walls of ancient Yucatan buildings. The decoration between the panels is scarcely less extravagant. We see great frets applied in fashions that the Greeks never thought of, latticework, and, at intervals, little temples in low relief, with roofs of serpents and feathers, above niches in which gods were seated cross-legged. This picture is a detail of the north range of the Quadrangle of the Nunnery at Uxmal

An illustration of the Mayan system of recording time.—From an inscription painted on the capstone of a vaulted chamber in one of the buildings of the Nunnery Quadrangle. The date *5 Ymix 19 Kankin* at Uxmal is presumably that of 1219 A.D. See description on page 382

The Stephens Sculptures from Yucatan

By HERBERT J. SPINDEN

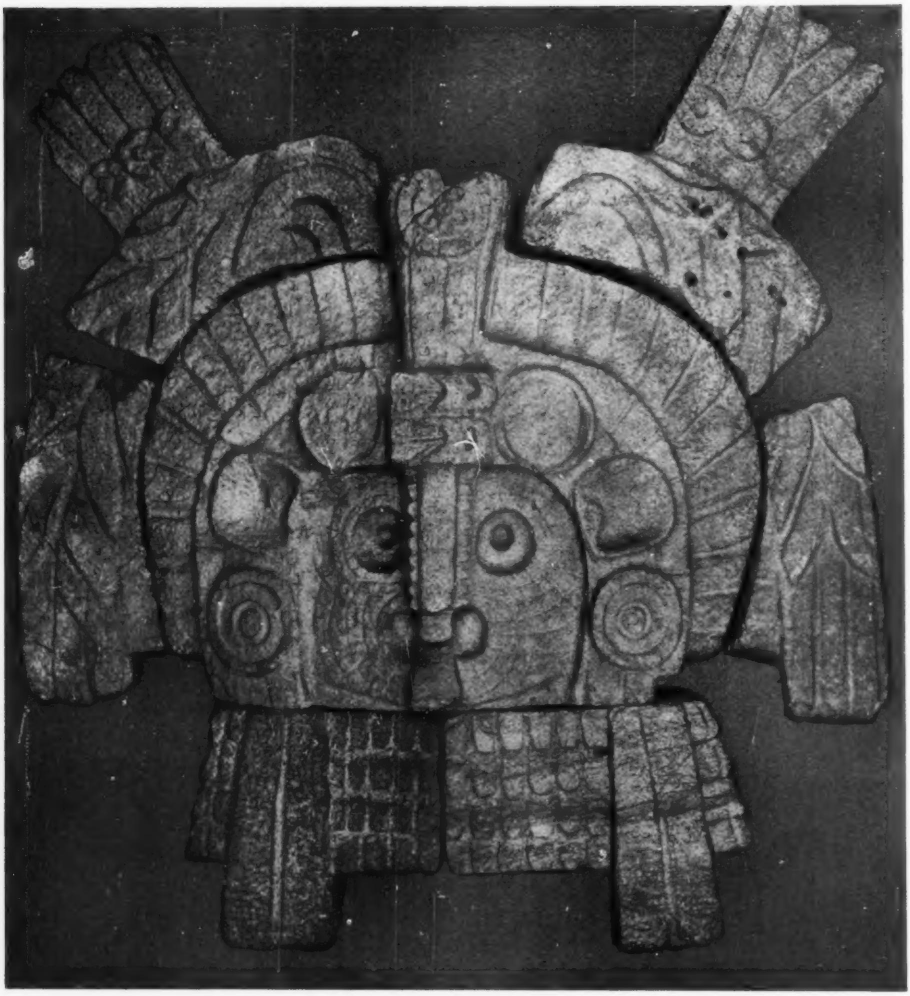
Assistant Curator of Anthropology in the American Museum

IN some old library on a gloomy day have you ever found as treasure trove the wonderful volumes of travel in which John L. Stephens describes the ruined cities of Central America which he was the first to explore? The four volumes, covering two expeditions in 1839 and 1841, are filled with steel engravings slightly foxed with time and dampness, even in the best copies. The engravings were made from the camera lucida drawings of Francis Catherwood, corrected by some of the earliest daguerreotype photographs, and they portray faithfully the monuments of Copan and the ruined temples and palaces of Palenque, Uxmal, Kabah, Labna, Chichen Itza, and numerous other sites of the ancient Mayan civilization. The narrative gives the facts of archæological interest, as well as a moving picture of native life and the vicissitudes of travel.

Few persons know that choice examples of Mayan art brought from Yucatan by Stephens have been kept for eighty years on an island halfway up the Hudson. These sculptures are now harbored in the American Museum of Natural History where they have been prepared for exhibition.

John Lloyd Stephens was a traveler, a writer of books, and an organizer of steamship lines and railroads. Born in 1805 and graduated from Columbia University, he first sprang into prominence because of travel letters sent back from the Near East to a New York magazine. In 1837 he published two volumes entitled *Incidents of Travel in Egypt, Arabia Petræa,* and *the Holy Land,* that are chiefly noteworthy today for their early descriptions of Petra, the city on the crossroads of Arabia where the temples are carved out of the cliffs. In 1838 he published two additional volumes, *Incidents of Travel in Greece, Turkey, Russia, and Poland.* These books passed through many editions in the United States and England.

In 1839 Stephens was sent by President Van Buren to negotiate a treaty with the Central American Republic, but this was then disintegrating into the present five republics and Stephens was unable to accomplish his mission. He did, however, carry his explorations far afield and brought forcibly to the attention of the world the remarkable ruins of ancient America, in his two volumes published in 1841, called *Incidents of Travel in Central America, Chiapas, and Yucatan.* He made a second trip to Yucatan for more careful and more detailed study and in 1843 published his last two volumes, *Incidents of Travel in Yucatan.*



This fine grotesque from the Quadrangle of the Nunnery at Uxmal is made up of several stones carefully mortised together by the pin and dowel method. The face is covered with a mask of turquoise (made of little pieces of turquoise carefully fitted together with other bright stones and bits of shell over a wooden base). It probably is intended to represent one of the gods. Four of the heads are still in position on the façade of one of the buildings at Uxmal (see page 383), while two heads (of which this is one) have fallen away or been removed

In those days travel in tropical America was attended with grave danger to health, because quinine was as yet unknown as a specific for the deadly malaria. Stephens greatly impaired his strength in these researches. For a number of years afterward he resided in New York, organizing the first steamship line between New York and Bremen. Then, with the discovery of gold in California and the necessity of transit across the Isthmus of Panama, he organized the Panama Railroad, being vice president and then president of the company. He went to Bogota and negotiated a concession for this railroad in 1849, and battled with fevers while personally managing the work of building the road. He died in 1852, a martyr to enterprise in the tropics. A statue of him stands in the Canal Zone; there is also a fine memorial window in his honor in the old Church of St. George on Sixteenth Street in New York City.

The collection of choice pieces of

carved wood and pottery that Stephens and Catherwood brought back with them was destroyed by the burning of a panoramic exhibition that Catherwood had arranged in New York. This panoramic exhibition showed the glories of ancient civilizations and bonded Egypt and Central America. The only specimens of Stephens' collection which were not destroyed at this time were the stone sculptures which fortunately had not yet arrived in New York by ship from Yucatan. These were later given by Stephens to John Church Cruger, of Cruger's Island, and now from the estate of Mr. Cruger's daughters they have passed into the possession of the American Museum of Natural History.

Cruger's Island is a wooded, rocky island in the Hudson near the station of Barrytown, opposite the Catskills. It was originally called Magdalen Island, and was bought from the Indians in 1688 by Colonel Peter Schuyler. Later, John Church Cruger, the great-nephew of Colonel Schuyler, built a mansion on this island, and on a rocky hill at its southern extremity made settings for the Mayan sculptures in the walls and broken arches of an imitation of a ruined church. Here the carved blocks of gray limestone from Yucatan showed in startling contrast against the dark background of lichened slabs from the native ledges.

Stephens in his last books laments the loss of a carved lintel beam of sapote wood from Uxmal as well as other specimens destroyed by the conflagration in New York. I quote his narrative[1] since it makes reference to the pieces now in the Museum:

> It was ten feet long, one foot nine inches broad, and ten inches thick, of Sapote wood, enormously heavy and unwieldy. To keep the sculptured side from being chafed and broken, I had it covered with costal or hemp bagging, and stuffed with dry grass to the thickness of six inches. It left Uxmal on the shoulders of ten Indians, after many vicissitudes reached this city uninjured, and was deposited in Mr. Catherwood's Panorama. I had referred to it as being in the National Museum at Washington, whither I intended to send it as soon as a collection of large sculptured stones, which I was obliged to leave behind, should arrive; but on the burning of that building, in the general conflagration of Jerusalem and Thebes, this part of Uxmal was consumed, and with it other beams afterward discovered, much more curious and interesting; as also the whole collection of vases, figures, idols, and other relics gathered upon this journey. The collecting, packing, and transporting of these things had given me more trouble and annoyance than any other circumstance in our journey, and their loss cannot be replaced; for, being first on the ground, and having all at my choice, I of course selected only those objects which were most curious and valuable; and if I were to go over the whole ground again, I could not find others equal to them. I had the melancholy satisfaction of seeing their ashes exactly as the fire had left them. We seemed doomed to be in the midst of ruins; but in all our explorations there was none so touching as this.

In the collection preserved by late arrival that now forms a fitting memorial to John L. Stephens, there are several fine sculptures from Uxmal. One of these comes from the western façade of the eastern building of the Nunnery Quadrangle. This particular façade is one of the most famous in the Mayan area. It is given in its full extent in an accompanying view, with the Temple of the Magician towering in the background. It served as a basis for the now discarded theory of Viollet-le-Duc that Mayan architectural decoration represents a survival in stone of a system of log cribbing and lattice-work. The central door is surmounted by three grotesque faces or mask panels, and similar ones in vertical series are bent around each of the corners. In the long sections between these mask panels are six ornamental constructions which certainly resemble cribwork of logs over a background of

[1] *Incidents of Travel in Yucatan*, Vol. I, p. 179.

latticework, and in the center of each of these is a grotesque head representing a face covered with a mask of turquoise mosaic and surmounted by a headdress of feathers. The central portion of this sculpture was supported in the wall by a long tenon at the back. Several separate pieces, forming parts of the headdress, were skillfully attached to the centerpiece by dowels and dowel pins. It is possible that the crevices in this composite ornament were filled in with plaster, and that the whole was painted in bright colors.

The Nunnery Quadrangle at Uxmal is a fine example of Mayan architecture of the Second Empire. In one of the buildings is an inscription painted on the capstone of a vaulted chamber and containing a date in the Mayan system of recording time. This inscription is given herewith (see page 379). The significant hieroglyphs are the first two in each line: in the upper line is recorded the day *5 Ymix, 19 Kankin,* and in the second line we read *18 Tuns, 13 Katuns.* In other words, this inscription records a day *Ymix* with the number *5,* which occurred before the completion of a *Tun 18* and a *Katun 13.* In the long count of the first empire this date equals 11.12.17.11.1. According to the most generally accepted correlation this date occurred in the year 1219 A.D.

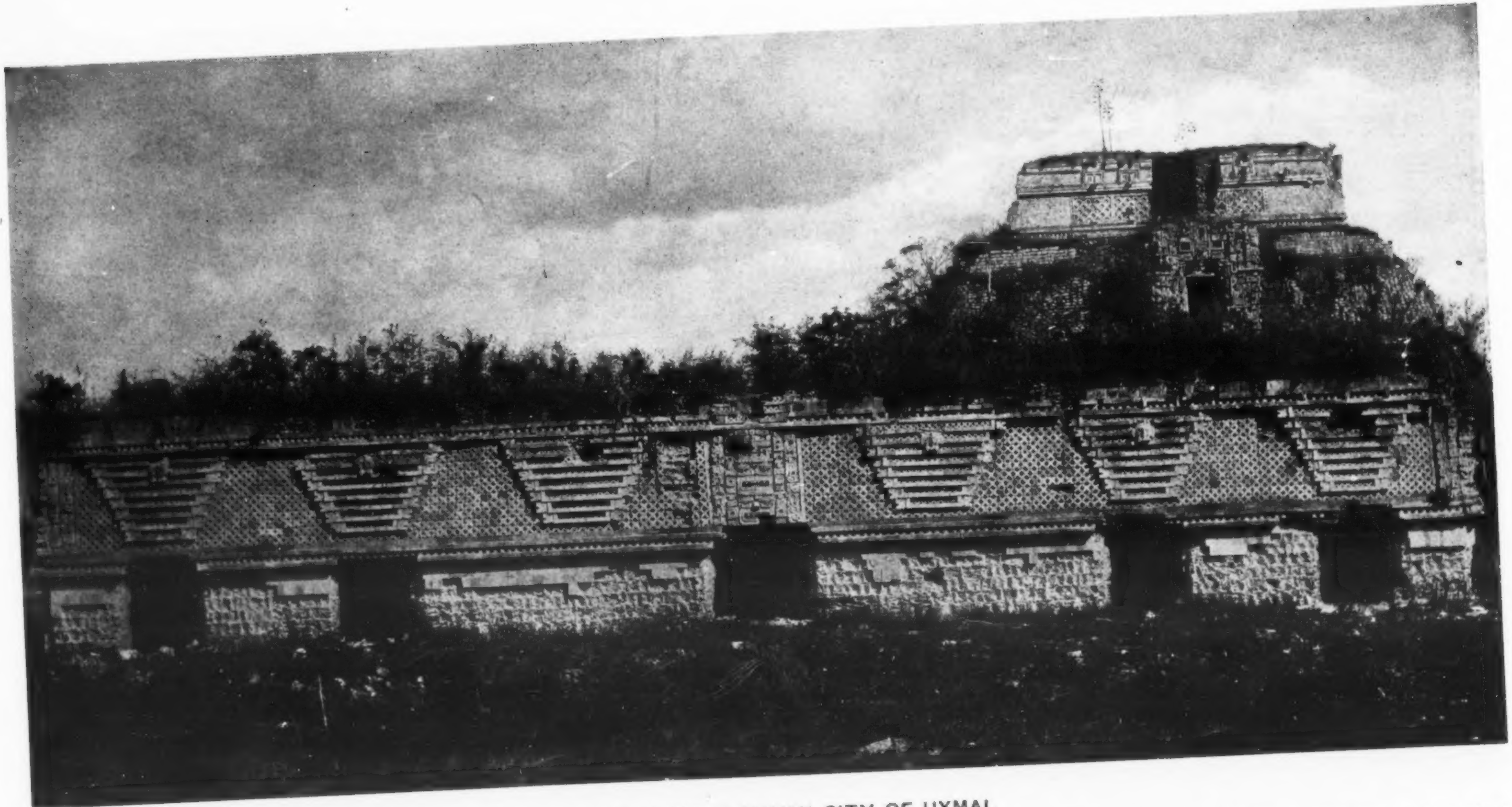
One of the pieces in the present collection—a portion of a headdress showing a fine series of plumes rising from a death's head—is figured in connection with Stephens' first description of the House of the Governor.[1] I quote his description of this famous building:

> **On this third terrace, with its principal doorway facing the range of steps, stands the noble structure of the Casa del Gobernador. The façade measures three hundred and twenty feet. Away from the region of dreadful rains, and the rank growth of forest which smothers the ruins of Palenque, it stands with all its walls erect, and almost as perfect as when deserted by its inhabitants. The whole building is of stone, plain up to the moulding that runs along the tops of the doorway, and above filled with the same rich, strange, and elaborate sculpture, among which is particularly conspicuous the ornament before referred to as la greeque. There is no rudeness or barbarity in the design or proportions; on the contrary, the whole wears an air of architectural symmetry and grandeur; and as the stranger ascends the steps and casts a bewildered eye along its open and desolate doors, it is hard to believe that he sees before him the work of a race in whose epitaph, as written by historians, they are called ignorant of art, and said to have perished in the rudeness of savage life. If it stood at this day on its grand artificial terrace in Hyde Park or the Garden of the Tuileries, it would form a new order, I do not say equaling, but not unworthy to stand side by side with the remains of Egyptian, Grecian, and Roman art.**

Several other pieces also come from the House of the Governor, and form parts of complicated ornaments built up out of separately carved blocks of stone. The subject is a human being with enormous headdress seated over the open jaws of a conventionalized serpent. Fortunately, a similar sculpture is still in place (see illustration on page 384), and in this case the open serpent jaws at the bottom of the decorated zone overlie a background of frets and latticework. Upon these jaws rests a round stool on which a human figure is seated. But the legs and arms that formerly extended out from the wall of the building have been broken off and the face greatly damaged. The headdress is lofty, and from it proceed enormous bunches of feathers which divide at the top and fall symmetrically on either side.

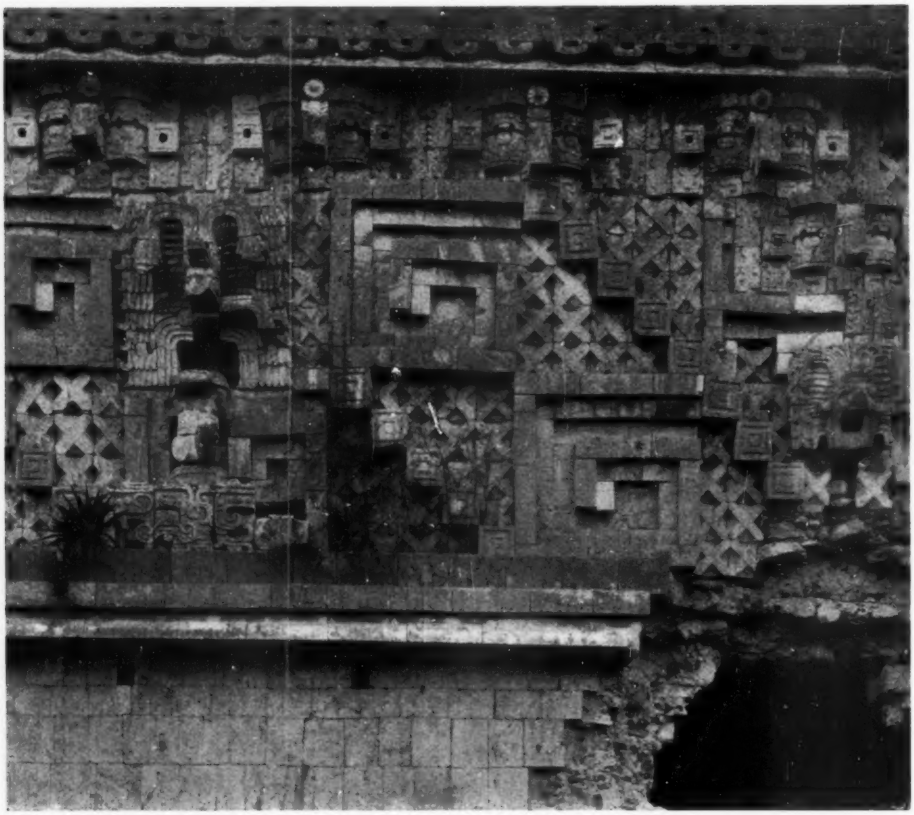
The fragments now in the American Museum show the stool, the broken figure (page 385), and sections of headdress which cannot be satisfactorily pieced together. As in the case

[1] ***Incidents of Travel in Central America, Chiapas, and Yucatan,*** **Vol. II, p. 429.**



IN THE ANCIENT MAYAN CITY OF UXMAL

This view of the East Range of the Nunnery Quadrangle, with the House of the Magician on its lofty pyramid in the background, is a justly famous one in the ancient Mayan city of Uxmal. The grotesque face (see page 380), wearing a turquoise mask and made up of several separately carved stones, comes from this façade. It will be observed that there are places for six such faces in the central positions on the decorative devices that resemble cribwork, and that four of them are in position. The built-up head with headdress in the Stephens collection may contain parts from the other two heads, especially since some of the joints do not fit properly



This detail of the House of the Governor at Uxmal shows clearly that the rich façade decorations are made by an incrustation of separately carved stones. The frets are three in one, each on a different plane, the lattice background is formed by square stones, each with a cross; the grotesque faces are likewise built up of parts. At the observer's left are the remains of a human or divine figure with great headdress of feathers, seated over the open mouth of a highly conventionalized serpent (if the reader will take the writer's word for it!). The battered figure that Stephens brought back and the parts of the feather headdress belong to such an assemblage as we see here

of the sculptures already described, the larger blocks were set into the wall of the building by long tenons (see illustration on page 387) while smaller blocks were attached to these by the device of the dowel pin. The material is a hard, blue-gray limestone which weathers well.

At Kabah, a ruin deriving much of its fame from a building entirely covered with great stone faces, Stephens discovered a small temple with sculptured door jambs and another temple with a finely carved lintel of sapote wood. This lintel was among the pieces destroyed by the conflagration. The stone door jambs were also excavated and form the most remarkable specimens in the Stephens collection. The original account[1] of the discovery follows:

Beyond this was another building, so unpretending in its appearance compared with the first, that, but for the uncertainty in regard to what might be found in every part of these ruins, I should hardly have noticed it. This building had but one doorway, which was nearly choked up; but on passing into it I noticed sculptured on the jambs, nearly buried, a protruding corner of a plume of feathers. This I immediately supposed to be a headdress, and that below was a sculptured human figure. This, again, was entirely new. The jambs of all the doors we had hitherto seen were plain. By closer inspection I found on the opposite jamb a cor-

[1] *Incidents of Travel in Yucatan*, Vol. I, p. 411

responding stone, but entirely buried. The top stone of both was missing, but I found them near by, and determined immediately to excavate the parts that were buried, and carry the whole away; but it was a more difficult business than that of getting out the beams. A solid mound of earth descended from the outside to the back wall of the apartment, choking the doorway to within a few feet of the top. To clear the whole doorway was out of the question, for the Indians had only their hands with which to scoop out the accumulated mass. The only way was to dig down beside each stone, then separate it from the wall with the crowbar, and pry it out. I was engaged in this work two entire days, and on the second the Indians wanted to abandon it. They had dug down nearly to the bottom, and one man in the hole refused to work any longer. To keep them together and not lose another day, I was obliged to labour myself; and late in the afternoon we got out the stones, with poles for levers, lifted them over the mound, and set them up against the back wall.

The plates opposite represent these two jambs as they stood facing each other in the doorway. Each consists of two separate stones, as indicated in the engravings. In each the upper stone is one foot five inches high, and the lower one four feet six inches, and both are two feet three inches wide. The subject consists of two figures, one standing, and the other kneeling before him. Both have unnatural and grotesque faces, probably containing some symbolical meaning. The headdress is a lofty plume of feathers, falling to the heels of the standing figure; and under his feet is a row of hieroglyphics.

The drawings of Catherwood which, in Stephens' book, accompany the descriptions just given are not up to his usual standard and seem to have been hastily made (see drawing at the left on page 389). Nevertheless, they have permitted the restoration of the top portion of one of the jambs, which has been lost. The sculpture is in flat relief and, in each case, represents, first, a standing warrior with an enormous feather headdress that rises far above the head and falls to the ground at the back. Secondly, there is a figure in suppliant pose, that may represent a common warrior before his commander, or some vanquished chief before his captor. The kneeling warrior hypothesis is the more likely in view of the fact that in one case the kneeling figure holds aloft a battle-ax made of four stone knives set in a club, while in the other case he apparently holds up the

This battered and broken human figure formed part of the façade decoration of the House of the Governor at Uxmal. A similar piece with wide-spreading headdress, carved on several stones, is still in position. Here the bottom drum represents a kind of chair or stool. The legs of the human figure formerly passed down in front of this seat

Section of an elaborate headdress of a human figure, employed in architectural decoration. The central part of the sculpture represents a skull

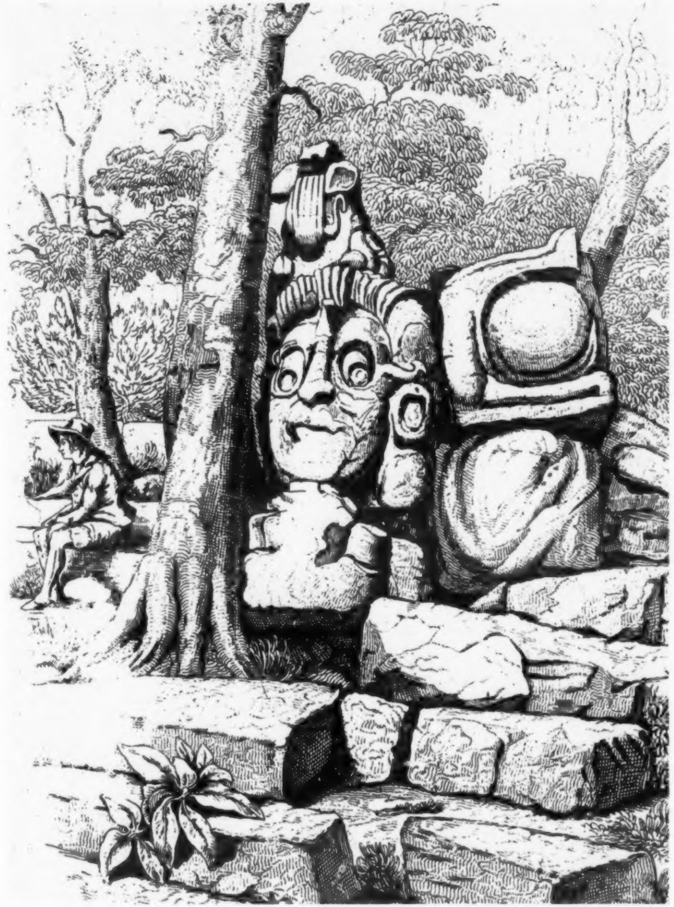
Another section of a headdress. The great feather headdresses were intended to fit one over the other. Note the free and graceful use of feathers

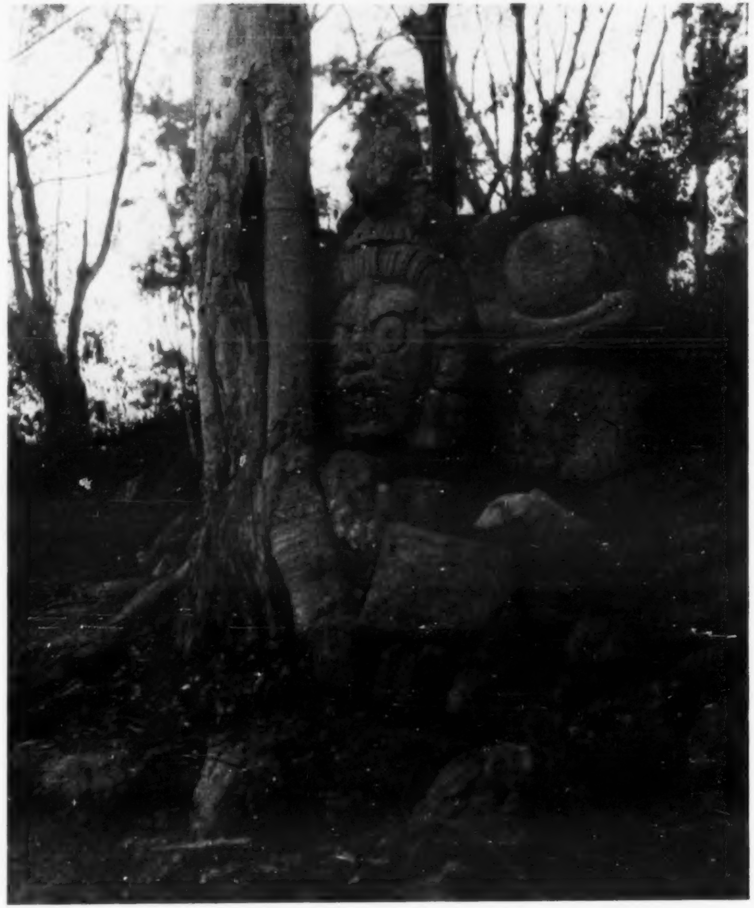
so-called manikin scepter, which is a ceremonial object seldom if ever shown in the hands of captives.

The larger figures are characterized by a slenderness seldom seen in Mayan sculptures. On the feet are sandals; below the knee, the legs are wrapped with a kind of spiral puttee. The body is clothed in a breechcloth while ornamental strips hang down from the shoulders. Wristbands and a necklace of stone beads are worn as well as ear plugs and nose plugs. It is this last mentioned feature which is responsible for the long, grotesque noses of the Catherwood drawings. The headdress is a boxlike bonnet covered with a surfacing of fine feathers (which we can imagine represents regalia of the most brilliant coloring). From the top of this bonnet rises a fountain of quetzal plumes sweeping to the front and to the back. The detail of one of these remarkable door jambs is admirably brought out in the fine drawing made by Mr. John Held, Jr., which is shown in combination with one of Catherwood's sketches and an actual photograph (page 389). The war bonnets of our western Indians pale into insignificance before such a gallant costume as this, for the long, flexible plumes of the quetzal are a most brilliant green, and we can imagine this color was set off by touches of crimson and gold.

In this view we see the long tenon by which the section of flaring headdress shown on the opposite page was firmly attached to the wall

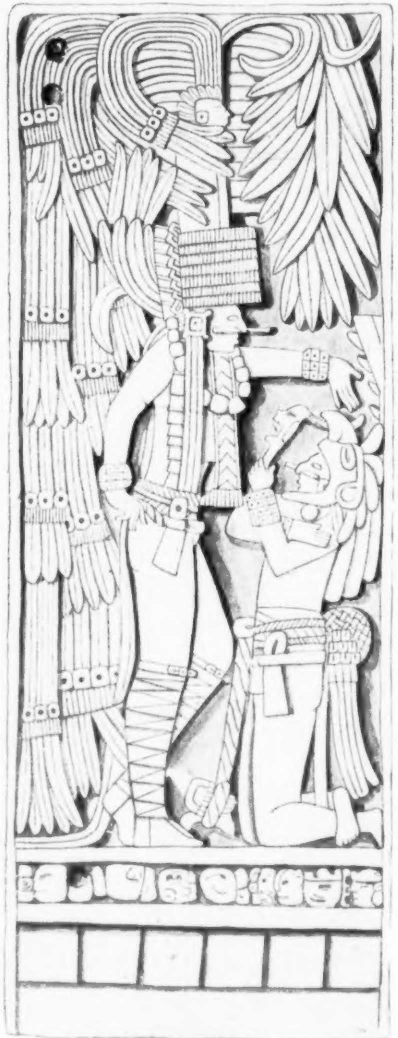
There is a narrow line of hieroglyphs under the feet of these figures, but unfortunately no dates that can be deciphered. Through their general characteristics we may place these sculptures in the eleventh or twelfth century A.D.





RECORDING AN INTERVAL OF NEARLY EIGHTY YEARS

A camera lucida enabled Francis Catherwood to make drawings of great accuracy during his journeys with Stephens. At the left is shown a grotesque head at the ancient city of Copan in Honduras, drawn by Catherwood in 1840, while at the right is a photograph of the same object made by the writer in 1917



ORIGINAL SCULPTURE, WITH PEN STUDIES

The three illustrations placed here side by side represent a sculptured door jamb from a small temple at Kabah. The one on the left is a rough sketch made on the spot by Francis Catherwood in 1840. Since the stones were to come to the United States, he did not consider it necessary to make a finished drawing. The illustration in the middle is an actual photograph of the sculpture in the American Museum, after it had been mended and prepared for exhibition. At the right we have a recent drawing by Mr. John Held, Jr., restoring many of the details according to original design. Mr. Held, when at Kabah, not knowing the stones had been removed, made an extensive search for them, since Stephens nowhere says specifically that he took them away from the ruined city

AFTER THE ERUPTION OF KATMAI, ALASKA[1]

THE STORY OF THE EFFECT ON CULTIVATED AND NATIVE VEGETATION

BY ROBERT F. GRIGGS

Assistant Professor of Botany, Ohio State University; Director of the Katmai Expeditions of 1915–16–17–18–19 for the National Geographic Society

Photograph by M. D. Snodgrass

A LAND BURIED UNDER VOLCANIC ASH

At the end of the first growing season after the eruption, October, 1912

The volcanic eruption of Mount Katmai in southern Alaska in June, 1912, buried the surrounding region under a volume of ash and pumice estimated at 4.9 cubic miles. This picture was taken near the town of Kodiak on the island of the same name, one hundred miles from the volcano. Even at that distance the volcanic ejecta covered the ground to a depth of nearly a foot. Only the spruce forests held their heads above the general desolation, almost all other plants having been completely covered over.

This widespread destruction of plant life has provided opportunity for an extensive study of the problem of revegetation, a task which was undertaken by Dr. R. F. Griggs for the National Geographic Society. On Kodiak the problem was solved by renewed growth on the part of the original plants after a protracted period of dormancy, but throughout the continental areas, where nearly every living thing was killed, the rehabilitation of the flora has gone on most slowly from wind- and water-borne seeds. During the first two years the gray-brown slopes of the island of Kodiak remained much as they were immediately after the eruption, and the barrenness was relieved by only an occasional willow or alder top which stuck through the ash and by sparse patches of strong-stemmed perennials such as lupines and fireweeds. Not until the third growing season was there any marked change; then the long buried perennials suddenly burst forth, covering hillside and valley with their original verdure

[1] The accompanying copyrighted photographs are loaned by the courtesy of the National Geographic Society.

Photograph by Robert F. Griggs

THROUGH THE ASH

The horsetail (*Equisetum arvense*) forced its way through great depths of ash. It proved the most important plant for providing cover over the deeply buried continental areas. Observations on its growth in gullies where the surrounding deposits were too thick to be penetrated, showed that it could push through three feet of ash. The horsetail is especially adapted for occupying extensive areas which otherwise would become shifting dunes. Its propagation is by perennial underground runners; it has pointed branches with scaly, teeth-like leaves which readily grow upward toward the light when completely buried, and it is sheathed in a hard epidermal coat of silicified cells which admirably protects it against wind-blown sand.

The trees of this continental region, as may be noted in the picture, are dead, although they were not overcome by the pumice shower. Presumably their leaves and buds were killed by a hot blast during the eruption, and the roots subsequently starved to death. Such hot blasts, sometimes of tornadic violence, are not uncommon in severe eruptions, and destroy every living thing.

The destruction of antecedent vegetation in the very deeply buried region around Mount Katmai itself was so complete that revegetation by wind- and water-borne seeds has been and will continue to be a slow process indeed, and here the problems of rehabilitation may be worked out in detail. The lupines are the most important pioneers, not only because of their large, heavy seeds which find lodgment when other seeds are blown away, but also because of their ability to utilize atmospheric nitrogen. In very sheltered spots other seeds have sprouted, especially those of the willow, which will probably form the pioneer growth over considerable areas. Out beyond the territory reached by the hot blast and destructive ash shower, rains acidulated by the volcanic fumes (sulphuric acid) did considerable though not permanent damage, destroying the season's crops

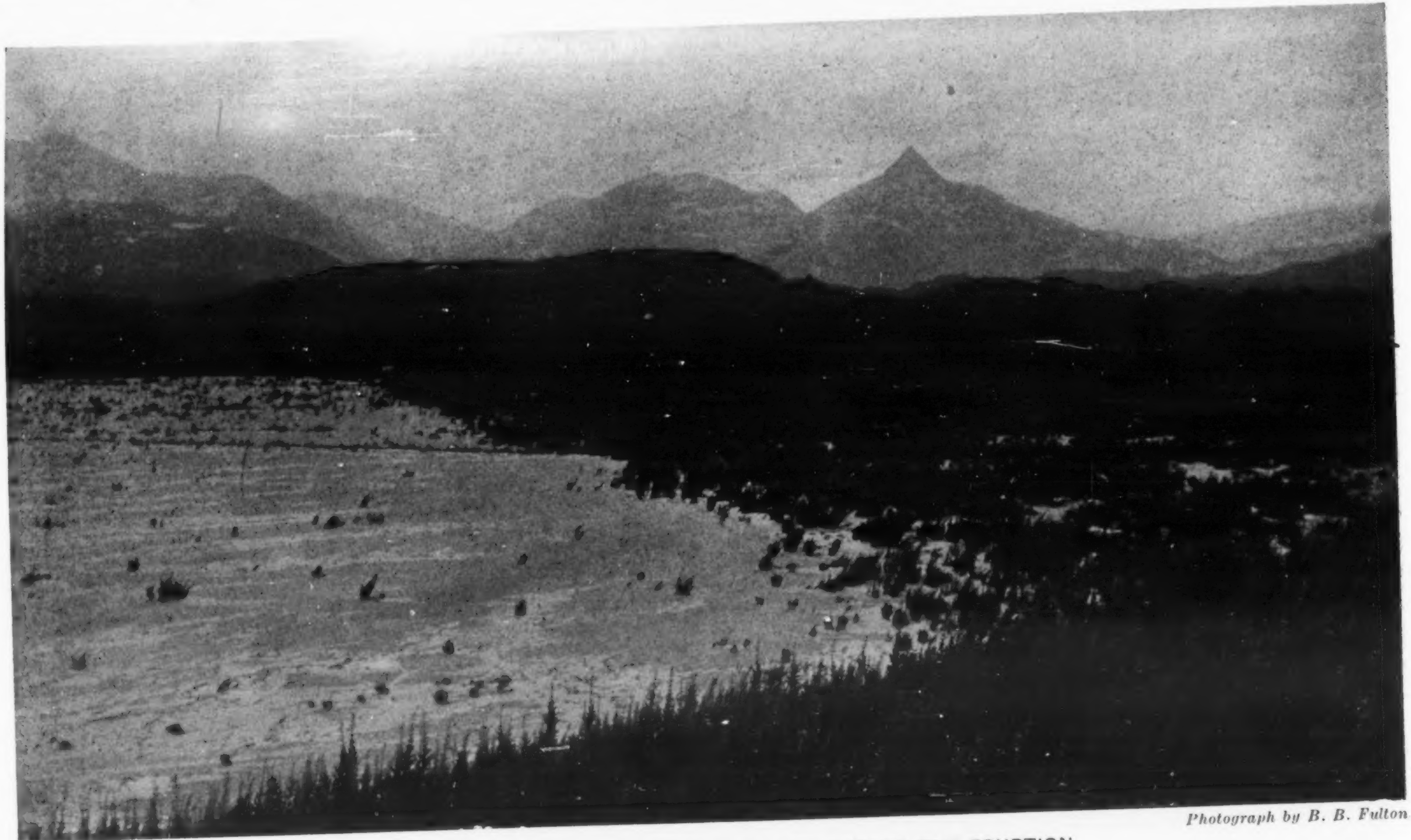
Photograph by D. B. Church

On Kodiak and in other places where the ash was not too deep the old roots began to send up new shoots during the second year. By the third growing season the mountains around Kodiak were everywhere green with a lush growth such as had never before been seen on the island. The grass which came up, chiefly the native "blue top" (*Calamagrostis langsdorfi*), penetrated twenty inches of ash in some places. This improvement of the pastures is not to be attributed to any fertilizing effect on the part of the volcanic deposit, which of itself forms a very poor soil, but rather to its action as a mulch, smothering the smaller herbs and so creating better growing conditions for the stronger grass. The ash also improved the physical condition of the soil, which was formerly heavy and mucky

Photograph by Robert F. Griggs

In sharp contrast with the luxuriant growth of old vegetation (photograph above).—This plot of timothy was sown in the untreated ash at the Government Experimental Farm at Kalsin Bay soon after the eruption. The seedlings came up well and were still alive after four years of growth but attained a stature of only three inches. The ash as a supporter of growth proved little better than sterile quartz sand. Where nitrogenous fertilizers were added to the deposits, a fair crop was harvested the first year but could not be duplicated a second season, for the ash required a complete fertilizer. Its infertility contrasts strongly with the fertility of soil derived from the slow weathering of volcanic lava such as underlies the great farming regions of Oregon, Washington, and Idaho

derived from the slow weathering of volcanic lava such as underlies the great farming regions of Oregon, Washington, and Idaho



Photograph by B. B. Fulton

EFFECT ON AREAS CULTIVATED AND FALLOW BEFORE THE ERUPTION

The important part played by the old vegetation in contrast with seedlings is apparent in this picture of a plowed field (at the left) near Kodiak. Cultivation just before the eruption destroyed the weeds; four years later the plowed land was still a barren waste with a clear line of demarkation between it and the area (at the right) covered with residual vegetation. The fine ash deposited on the previously cultivated plot was kept moving by the wind so that few seedlings could find a sheltered spot. Wind and water are, however, rapidly removing the ash altogether, so that where the deposits were not more than a foot thick, the original soil is now being exposed. The effects of wind and water are particularly evident on the mountains, from which a large part of the ash will have been blown out to sea within a few years, leaving the grasses and lupines to start the slow task of rehabilitating the alpine heath which was almost completely destroyed. The lowly alpine plants were unable to penetrate the heavy blanket of ash which so long covered them

Photograph by D. B. Church

SHIFTING DUNES OF ASH

The resuscitated plant life was invaluable as an agent for binding down the ash and protecting the surface of the ground, for wherever there were no plants, the wind quickly picked up the loose pumice, driving it in destructive blasts or piling it into even more destructive dunes. At the right in the photograph is seen a dune of wind-blown ash near Kodiak. Although it is partly overgrown on top, its shifting sides provide an inhospitable foothold for seeds. At the left the protective action of the forests is well illustrated. The trees shielded the ground from the wind and increased the humidity of the air, permitting seedlings to take root

Photograph by Robert F. Griggs

HARDY PLANTS WHICH FINALLY SUCCUMBED

The abrasive power of the particles of ash, which are lighter and more angular than those of shore sand, lopped over and cut to pieces the weeds. It tore the bark from the trees and even ate into their wood. Wherever plants stood in groups, the ash lodged behind them like drifts of snow several feet deep. The resultant accumulation resembled the shifting white dunes of the seashore, for the more rapidly the plants grew out the more sand they collected, until finally a hill was formed or the growing vegetation was engulfed. The willows, which could readily send out new roots at any level, maintained themselves fairly well, but such plants as the fireweed (*Chamænerion angustifolium*), shown in the photograph, were soon so deeply buried that their conducting system could no longer maintain connection between leaves and roots

"THE PRIDE OF THE CAVES"

The walls of the Oregon Caves are embellished with glistening crystalline limestone,—often with graceful traceries in delicate or bold relief of what seem flower and fruit designs. No one can gain even a small idea of the beauty of the caves without seeing them. Photographs give only the form of these decorations, nothing of the color or finish.

The Oregon Caves were discovered in 1874 by a hunter, Mr. Elijah Davidson, who still lives near by; and since 1909 they have become a much frequented national monument of the United States. They are made up of a succession of marvelously beautiful underground halls with irregular connecting corridors and galleries. Like other limestone caves these have been formed by the erosive and solvent action of water charged with carbon dioxide. The rock dissolved away and the channels were enlarged and extended by underground streams (probably during the Glacial period). Then in turn redeposition of lime carbonate has been slowly effected by saturated waters percolating from above. In this way the spectacular stalactites and stalagmites of the Oregon Caves have been molded and the successive crystalline coatings laid down on the walls and floors

Here the dead, shining columns, like spectral trees, have given the name, "Petrified Forest"

The Oregon Caves[1]

REMARKABLE "MARBLE HALLS" OF JOSEPHINE COUNTY

By IRA A. WILLIAMS

Geologist, Oregon Bureau of Mines and Geology

NEAR the southwest corner of Oregon in the rugged hills of the Coast Range is a much frequented national monument, the Oregon Caves. Joaquin Miller some years ago designated this great series of then only partly explored caverns, "the marble halls of Oregon," and they are generally known by that name at the present time. The appropriateness of this title promptly appeals to every one who visits these caves, for they are, in reality, a glorious succession of halls, and these halls, as well as the connecting corridors and avenues, galleries and chambers, are of glittering white marble.

This monument is located near the west edge of Josephine County, Oregon, which is separated from the Pacific Ocean by Curry County, whose coast line is forty miles to the westward. It is less than seven miles from the Oregon-California line, at an alti-

[1] The presidential proclamation which withdrew the Oregon Caves from private ownership and established them as a national monument is dated July 12, 1909. The monument is administered by the United States Department of Agriculture, and since it is in the Siskiyou National Forest, comes under the jurisdiction of the Forest Service branch of that department. In keeping with sound national policy, reasonable expenditures have been made in each of the last several years, and are still being made, to render this natural wonder accessible to the world. An excellent trail now reaches it from Williams Creek ten miles to the northeast, where there is a suitably equipped summer camp station conveniently reached by automobile over a twenty-seven-mile stretch of fair road from Grants Pass, which is on the main line of the Southern Pacific Railroad. From the west and the head of automobile travel there, five miles of trail bring one to the caves by way of the Grants Pass-Crescent City (California) Highway. Plans are now under way for building an automobile thoroughfare direct to the main entrance of the caves, a project to be most highly commended and encouraged, and an entirely feasible one, it would seem, as forest and mountain road construction goes.

tude of approximately four thousand feet above the sea. Prior to discovery its entrance was doubtless concealed for centuries within the shadows of the sturdy firs and western hemlocks, which, with the celebrated Port Orford cedar and Sitka spruce, chiefly clothe the slopes of the Oregon Coast Range and the summit heights of the connecting range, the Siskiyou Mountains.

Because of its location in Josephine County, the Oregon Caves were long called locally and in the literature, "Josephine Caves." Their discovery dates back to August 6, 1874, when, it is related, Mr. Elijah Davidson (who still lives near by in the valley of the Applegate River) in pursuit of a bear came to the lower entrance, in the darkness of which the wounded beast had taken refuge. The history of the exploration of the caves will probably never be written in detail, although it would appear to be one in which fortunately unsuccessful attempts at commercial exploitation have had an ignoble part. Nor do we need to be told that the caves were frequented for years before the protecting hand of the Government was extended in order that they might be preserved for all time; for the infallible mark of the careless person is there, the one who, when not under surveillance, forgets that nature builds not for him alone, and that he should not mar, or maliciously destroy, some of her most beautiful creations.

The trail to the Oregon Caves.—Prior to the discovery of the caves, less than fifty years ago, the main entrance had lain hidden among the firs and spruces of the Siskiyou forest. Even today the caves are thirty-seven miles from the nearest railway station (Southern Pacific). A good road, however, covers the first twenty-seven miles and from the end of the road the United States Forest Service has cut a trail. A project is now under way to build an automobile highway directly to the entrance

The Oregon Caves are representative of a type of underground cavern by which limestone formations are characterized the world over. The geologist would explain that marble is only a limestone that has become hardened and crystallized by the action of those agents in the shell of the earth—heat, pressure, and circulating water—that modify the physical condition of rocks everywhere. Caves are formed in rocks whose substance is relatively easily dissolved away. Limestone is the most common one of these, and marble, which is but a crystalline limestone, shares this same susceptibility to the solvent action of earth waters.

The best known limestone caves of the world are sources of wonder because of their great size and the intricate and extensive ramifications of the underground openings. Streams of water flow through some of them, and sightless fish and other forms of life that are born of darkness inhabit them. In contrast, the Oregon Caves are a

series of relatively small, often narrow passageways largely of extreme irregularity in shape. With the exception of entrancing little Cave Creek which issues from the lower opening, the explored parts are free from running water, while of cave life none is known to exist. But it is the fortunate absence of running water and the relatively small size, that have permitted nature to spread with extravagantly lavish hand everywhere within these caves the most elaborate of decorations. Crystalline embellishment is upon the floors, pendent from the ceilings, and tastefully molded against the walls, so that rarely does a point of uncovered rock show through. Stalactites and stalagmites reach toward each other, one from above, the other from below. In places they join as though to form supporting columns. Festoons of spectacularly ornate pattern cling to projecting ledges, while again there is the most delicate of rock-fretted tracery to please the artistic eye.

And what is the story of the formation of these caves with their distinctive and bewilderingly ornamental features? It is indeed a short one to relate, although it tells of a series of events—geologic events, 'tis true—some of which, as human passions are moved, possess a tinge of romance, others of tragedy. Limestones are a common variety of rock in nature and are known to be formed under conditions that obtain in the depths of the ocean. They are now found as a part of land surfaces because earth movements have carried them into positions above the level of ocean waters. During the process of their accumulation, and later during their elevation above the sea, their substance became compacted and hardened into a firm rock. It rarely happens that uplifting forces act so gently and so uniformly as not to disturb seriously rock layers that are involved in the movement. The beds are subjected to both compression and tension, and become curved or twisted, bent, kinked, and frequently rent apart and broken. When the disturbance is sufficiently intense the nature of the rock material itself becomes so changed that in some instances the original character may be scarcely recognizable.

Just so has it been with the body of marble in which the Oregon Caves are found. Originally a granular lime-

The Oregon Caves honeycomb the structure of a great body of marbleized limestone which is in the northwest slope of Grayback Mountain, a peak whose summit is more than 7000 feet above the sea. There are two entrances; this, the lower, lies at about 4000 feet altitude

stone, it is now a beautifully mottled grayish white marble, in appearance no different from many architectural marbles that lend gentility of character to the structure or finish of enduring buildings everywhere. What may have been we know not how extensive a body of limestone at one time, is now a comparatively narrow belt of marble tilted up on edge and squeezed into elongated lenticular form. It is pinched in between other rocks, some of which were once clays but now are so completely transformed as to bear little resemblance to that plebeian substance.

It would seem that a rock with even the reputed stability of marble could scarcely be expected to withstand such vigorous treatment without showing at least some signs of reaching its limitations. And the most unmistakable evidence that is present are the occasional crevices which traverse the face of almost all the outstanding marble cliffs, of which there are a plenty in the region. The marble gave way to the strains of uplift, and found relief in the opening up of cracks and fissures which today are the characters by which we decipher the exigencies of its past history.

Far more than with the distant past, however, have these cracks and crevices had to do with the events of more recent days in which our interest now centers. Doubtless most of them were small when formed, many of them so minute as to be scarcely discernible. But small and great, they became from the very first the natural lines of easiest movement for the underground waters that are ever present and in motion, seeking out their level beneath the ground, just as waters do upon the land surface. Percolation through the pores of soils and of all rocks is the normal movement of ground waters. If these pores enlarge into cracks, or, better yet, if the substance of the rock dissolves by the action of the water itself, cells or cavities or even tunnels result. That is precisely what took place in our bed of marble, and at once openings of any size came into being, more and more of the circulating waters were attracted, until subterranean streams became established. Streams beneath the ground perform work just as do surface streams. Once a beginning is made, they erode their channels and enlarge their valleys to the limit of their ability as determined by volume of water and by gradient. At the same time percolation in and dissolving of the surrounding rock walls continue until rooms are formed, and the rock becomes honeycombed, or, in the extreme case, the structure breaks down entirely.

There is no alternative but to conceive that such a series of events at the outset produced the openings that finally gave us the Oregon Caves. Solution of rock substance started these openings; subterranean streams assisted to enlarge them and to carry away both eroded and dissolved materials. In order for this process to go merrily on for as long a time as it did, and to accomplish so much, there must have been an abundant supply of water, more by far than at the present time.

The need for a plentiful water supply at once carries one in thought back to a time immediately preceding the present, the closing days of the Glacial period in this region. At this time of moderating temperature, when the perennial snows of countless winters were melting away from the higher lands, accessible parts of the earth's exterior must have been quite saturated with water. Actively moving waters pick up and carry away the materials with which they come in contact. Quiet or sluggish waters are quite as likely to deposit parts of their burden in favorable positions as they are to take them away from others.

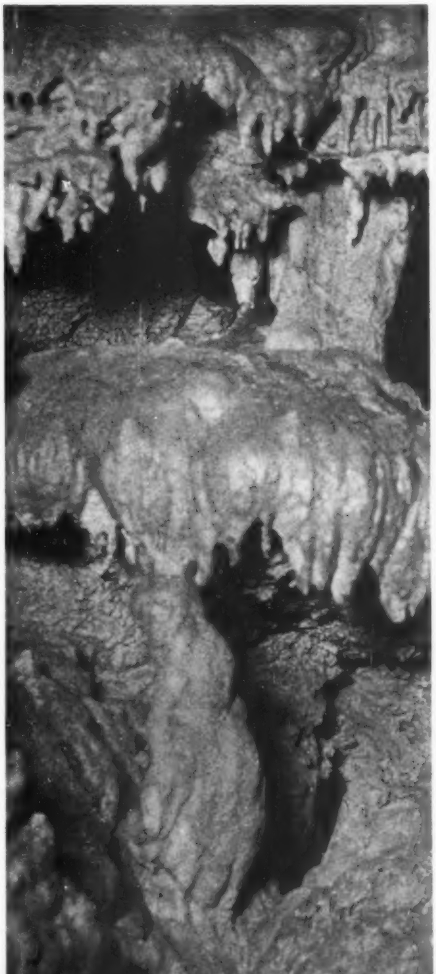
And so there came a time, as glacial conditions slowly disappeared, when the quantity of water finding its way

into this body of marble was no longer sufficient to accomplish any great amount of erosive work. The dwindling and even actual drying up of underground streams left the great openings which they had been instrumental in forming; their former courses, the deep cañons, the gulches, the dark channels which they made and occupied, became the halls, corridors, and tunnels of the caves we frequent today.

When underground passages become too large their roofs collapse for want of support and the walls tumble in, just as we see they have done in the more spacious rooms in all known limestone caves throughout the world. In limestone regions the land surface itself is pitted by an undermining of the rock beneath, and sinks, natural bridges, etched pinnacles, and balanced rocks result.

Fortunate indeed it is for us who now look on, that the processes of destruction in the case of the Oregon Caves did not proceed so far as to injure irreparably the structure of the rock formation which long harbored them. Innumerable openings were formed, it is true, but so far as we have yet been privileged to observe, very few were so large that their walls and roof have failed to support them. It is this fact largely that has provided the opportunity which we enjoy today of studying one of the most intricate, assiduously perfect pieces of natural handiwork to be found anywhere. And although its production was the task of ages, as human generations are counted off, the transcendent perfection with which it was carried out could have been accomplished only in the profound quietude of the dungeon, far from the light of day, where the changes of the seasons were of no avail, and where the storms of winter and the balm of outside summer were ineffective and unknown.

Nature appears to object to cracks and crevices; to her they are blemishes, imperfections in the earth structure which should be repaired. And she sets zealously about the task of healing such breaks. Openings in rocks anywhere are elements of weakness, and nature's



A detail of the decorative finish in "Neptune's Grotto."—Multiform shapes and designs have been fashioned by the lime-laden waters—mostly fantastic but occasionally realistic. Note in the lower foreground the female figure known as "Neptune's Daughter." Often the deposits are in the form of broad sheets, like draperies of waving outline, as though possibly currents of air may have coursed through the darkness of the galleries in the past. In fact, even today in certain of the chambers drafts of air are strong enough at times to extinguish an unprotected light

plan is one by which she proceeds to fill the gaps and thus strengthen the structure. She fills them with the materials nearest at hand. In this case, the materials of repair are the same as those of which the rock—marble—is itself composed. Chemically it is lime carbonate; as a mineral it is calcite when pure and crystallized.

The "cauliflowers" in the "Petrified Gardens" required thousands of years "to bloom." The water flowing, dripping over the irregularities of the wall, slowly deposited the coating of lime carbonate, particle by particle, layer upon layer. The caves are officially open to the public from May 15 to September 15 each year

Water is the agent by which the healing process is carried on. It dissolves in places of plenty and transports to points of weakness, where it skillfully applies layer after layer, as a soothing lotion to an open sore. The jagged surfaces of rough rock walls are coated over, furrowed ceilings are smoothed out, floors harmoniously carpeted to match. In some places pillars rise from the floor or drop from the roof as though temporarily to steady a precarious span. And it seems to be a characteristic of the manner in which this agent of restoration works, that there will be found at almost any stage the most exquisite surface finish. Ceilings and walls are frescoed with well-nigh unwarranted elegance, alcoves, balconies, and corridors are fringed with the most immaculate of draperies, floors silk-lustered and never meant for the tread of feet. Ever dissatisfied, it would seem, with the results obtained, a fresh coat is put on, and then another, each differing from the one it covers up—not in substance, but varied in design infinitely or infinitesimally, as the case may be.

Small openings are thus soon filled, and the

former walls are finally and securely tied together by a reticulated network of crystalline mineral which may vary from a mere filament in width to veins several feet across. These are the scars that result from the healing of the wound, and it is through them only that, oftentimes, we are able to decipher the course of past events. In the Oregon Caves, however, few of the openings have yet been closed. We have, as it were, caught nature in the act, when the process of healing is but just well started. In most of the rooms in the caves, only the "sizing," to use a builder's term, has been applied as a background for later finish. We can observe that the work is still going on in many rooms, although obviously not so actively as it has in the past. In others the finishing touches appear for the present to be completed and activities temporarily suspended.

From our standpoint, therefore, it is a stroke of extreme good fortune that the filling of these caverns has reached no more advanced stage than it has. Had it not yet begun, we should today gaze upon lusterless rock walls, etched and roughened and angular, and peer into somber depths that would return scarce a single responsive flash to our swaying candle flame. As it is, with the process just well under way, marvels are revealed at every turn. Not a room or passageway but has received the painstaking attention of the master hand. The formations are curious, and many bear fancied or actual resemblance to interesting objects of various

A detail of crystalline deposit in the "Queen's Reception Room." —It is no vagary of the mind that the graceful figure of her majesty is to be seen confidently poised beneath the encircling archway of this massive, rock-bound throne

THE CARELESS DESTROYER OF NATURAL BEAUTY HAS BEEN EVEN HERE

The "Cathedral Chimes" in "Judicial Hall" (upper photograph) have the appearance of a musical instrumen They are pendent stalactites which produce musical tones when cautiously struck with a stick or piece of meta Obviously due caution has not always been observed by the players of these chimes. The lower photograph, taken i "Joaquin Miller's Chapel," presents a view of the "Washington Monument" of the caves which rises far above th heads of tall men

kinds; they are weird, fantastic, awesome. Always and everywhere there is the glimmer of crystal facets in response to the searching movements of our lights; in places the walls glow softly as the sheen of velvet, elsewhere they are lighted and ablaze with myriads of dimly reflecting mirrors, the twinkle of distant stars; and then again, and over and over, are thrown back the scintillating fire and flash and color play of the true-cut diamond.

Systematic exploration of the numerous intricate ramifications of the caves has not yet been made. Doubtless many openings not now known will be discovered, and passageways made so they may be reached in a tour of the caves. Starting in at the lower or main entrance, the visitor now travels about three and one half miles underground, reaching daylight again in three hours, from the same opening.

Picturesque, fantastic, sometimes significant names have become attached to objects within the caves. On entering, one soon crosses the "River Styx," and moves cautiously past "Old Satan's Caldron." Later "Cathedral Chimes" and their harmonious tones prepare him for a passing view into "Bottomless Pit," whence with due solemnity of manner he passes "Adam's Tomb," and gazes into "Jacob's Well" near where, in prayerful posture, is the "Kneeling Camel." In "Old Nick's Bedroom" we see yet another of his Satanic Majesty's exquisite apartments, and then by way of the "Coral Gardens" we approach "Queen Josephine's" place of abode. Farther on we are treated to a safely distant glimpse of the "Bacon Room" and through the "Wiggle Hole" come to "Elijah's Statue" (named in honor of the discoverer of the caves). Beyond "Fat Man's Grief" we skirt the "Graveyard," and, rather out of the customary order of events, are then ushered into "Joaquin Miller's Chapel." The "Ghost Room" is fifty feet wide by forty feet high, perhaps a few hundred feet in length, and, it is said, is the largest room yet opened up.

Another view in "Joaquin Miller's Chapel," which, again, tells nothing of the magnitude of the cavern formations, their color, their reflective surfaces—just as it conveys no sense of the unending solitude—and the silence except for the drip, drip of water—in which these caves lie and have lain during the age-long process of their formation. That the formation is still in progress in various parts is of high value to our understanding of how it has all come about

To describe the Oregon Caves adequately is not possible. Photographs record in their mute way the outlines of things, but give no vivid expression of life in the objects they depict. Nor do they convey in the slightest degree a sense of the unending solitude in which these cave objects grew and now exist,—a sensation the thrill of which can come only to him who frequents these underground ways, and who thoughtfully reflects upon their meaning and the lessons that they teach.

The Water Supply of a Great City[1]

A RECORD OF THE CONSTRUCTION OF THE CATSKILL SYSTEM FOR NEW YORK

By CHARLES P. BERKEY

Professor of Geology, Columbia University; Consulting Geologist, New York City Board of Water Supply

THE water supply of every large city is a serious problem. Local sources which may have been entirely adequate in the beginning are outgrown or have become hopelessly contaminated, and, ultimately, more or less distant back-country sources must be developed.

These additional supplies are usually mountain- or hill-country surface streams with large enough drainage area to furnish sufficient volume and of good natural purity if possible. If there is any question on that point, steps are taken either to guard the supply from contamination or to filter the water or otherwise treat it to accomplish the desired result. More rarely, artesian well supplies may be relied on, but the natural conditions that make them possible do not everywhere exist.

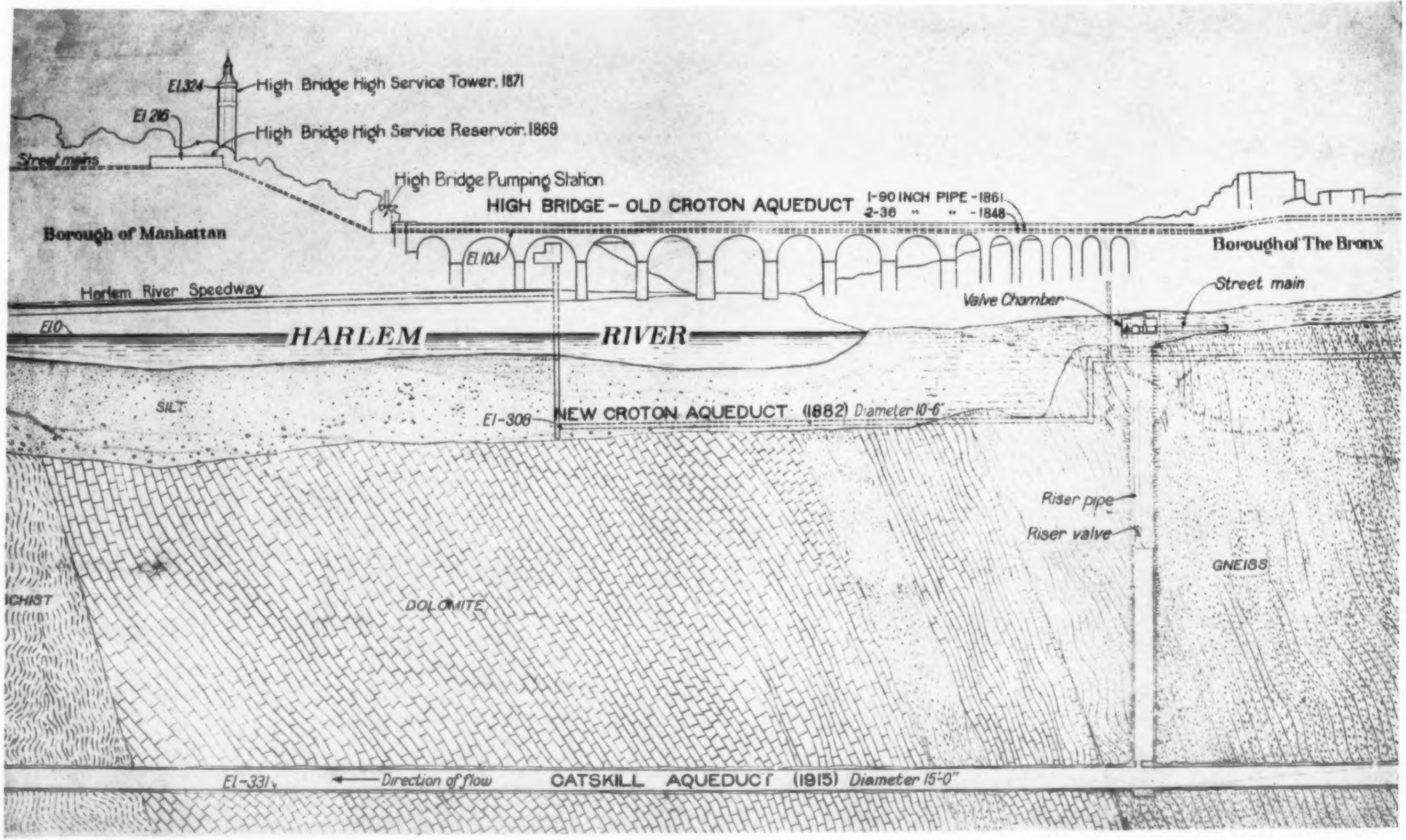
Rapidly growing cities such as New York present an ever changing problem. The population of New York increases something like a hundred and twenty-five thousand a year,—about as many people as live in Albany or Bridgeport or New Haven. Every five years its increase amounts almost to a Boston or a Cleveland or a Baltimore. In the early days such phenomenal growth could not have been foreseen, or provided for even if it had been foreseen.

In 1820 New York had a population of probably not more than 110,000. Now, a hundred years later, it has more than 5½ millions, roughly, fifty times as many people. In that time the water supply has been outgrown many times. At first well waters and surface waters within the city limits were used. Even distant supplies for those days are now within the enlarged city limits and New York has long ago abandoned nearly all of them in favor of still more distant supplies from Long Island, the Highlands, and the Catskill Mountains.

Brooklyn has always had a complex supply, both in quality and source. Separate companies developed local supplies and served limited sections of the city. Some of the supplies came from surface streams, some from artesian wells or deep wells, and still others from shallow wells. Most of these have gradually been reorganized into more of a unified system, but at its best, Brooklyn has had an inadequate supply and long ago began agitation for development of new water resources. The city had at one time large plans for the development of the Long Island sources, but legislative obstruction prevented their execution. There has been a good deal of expansion, however, and a total of something more than 150 million gallons of water a day is furnished from the wells and streams of the south side of Long Island.

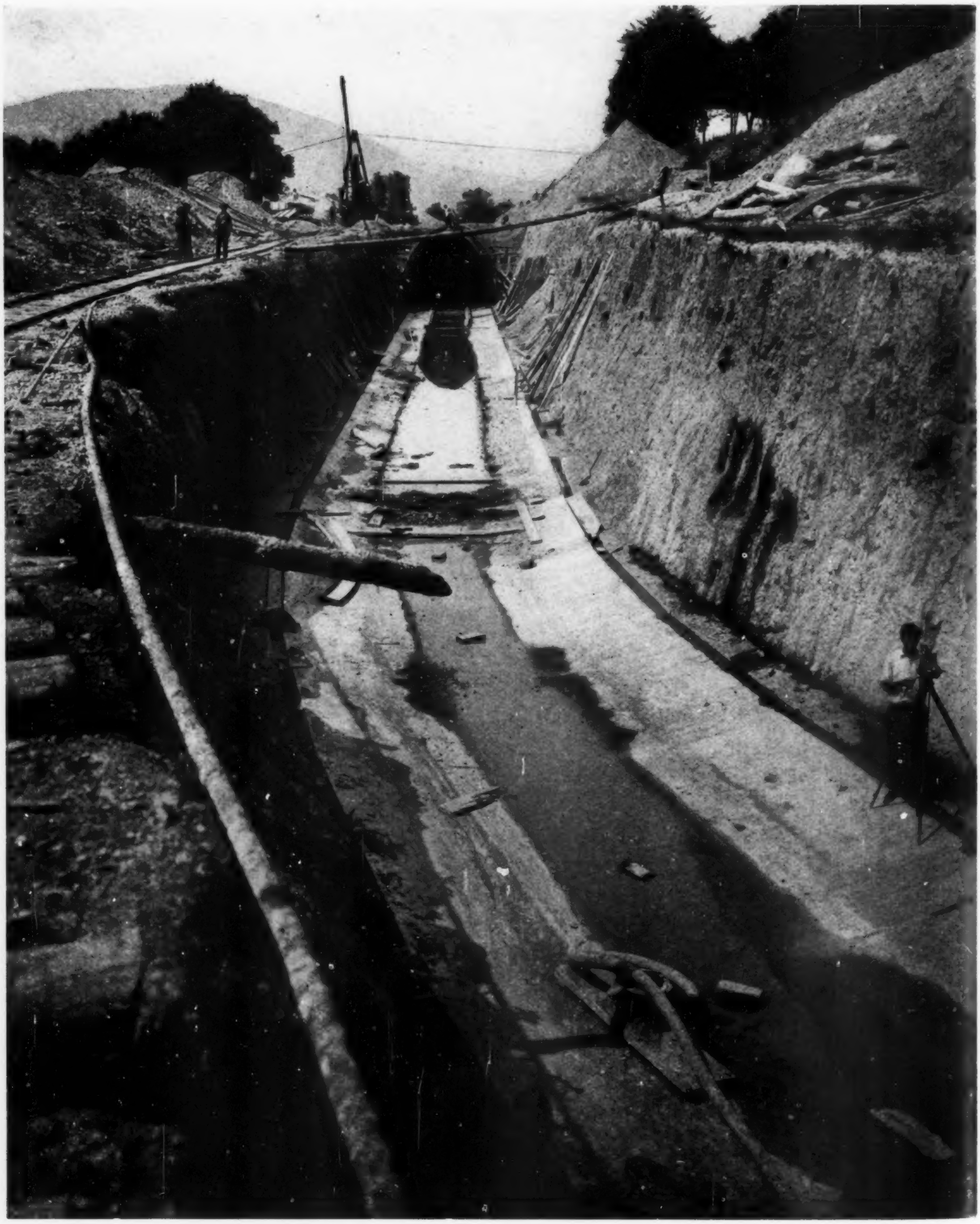
In 1848 the first Croton Aqueduct was completed, bringing water from the Croton River, a distance of thirty-four miles, crossing the Harlem River on High Bridge, one of the engineering landmarks of the city, to the reservoirs in Central Park. This original aqueduct was capable of delivering 80 million gallons a day. In 1890 the New Croton Aqueduct, thirty-one miles long, was finished. It is capable of carrying 300 million gallons a day. It enters Manhattan by a tunnel in rock beneath the Harlem River a short distance north of High Bridge.

[1] With official photographs, many of which have not been reproduced heretofore, taken during the construction work, and used by courtesy of the Board of Water Supply, New York City.



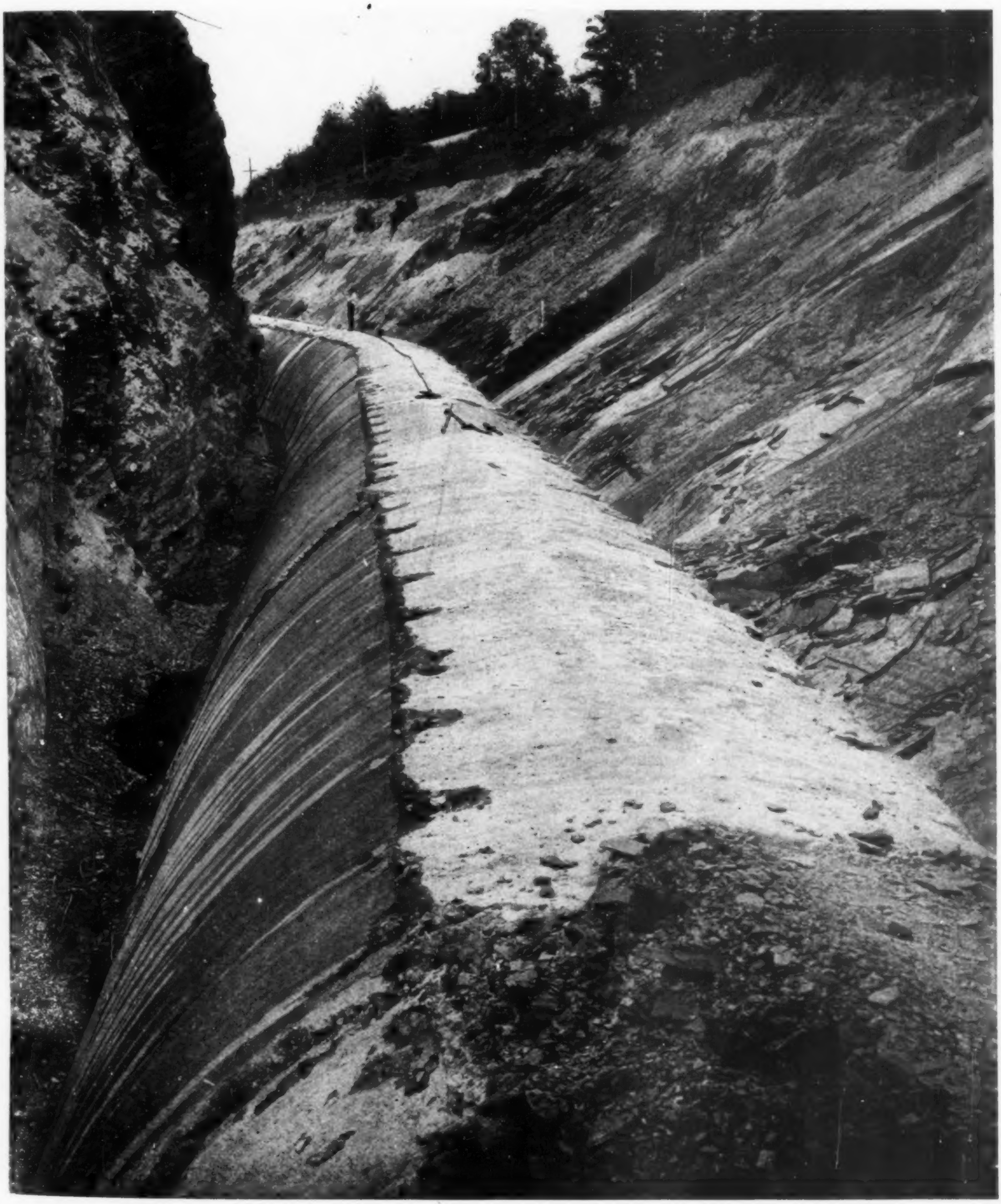
THREE AQUEDUCTS INTO NEW YORK CITY

Diagrammatic comparison of the "Old Croton," the "New Croton," and the Catskill aqueducts, with geologic cross section of the rock structure in the vicinity of High Bridge near which all of these conduits cross the Harlem River into Manhattan. The Catskill Aqueduct tunnel was put through solid rock 331 feet below the surface of the Harlem River (below sea level), the New Croton at 308 feet, and the Old Croton is carried over the river on High Bridge



A CUT-AND-COVER TRENCH TYPE OF AQUEDUCT

The Catskill Aqueduct under construction through country whose elevation made the cut-and-cover type of structure possible.—It is essentially a great trench, with a concrete floor and arched roof, graded so that water will flow of its own accord slowly toward New York City. The finished conduit is 17 feet high by 17½ feet wide, inside measure, with walls nowhere less than 12 inches of solid concrete



THE CONCRETE CONDUIT SEVENTEEN FEET INSIDE MEASUREMENT

An almost completed stretch of cut-and-cover aqueduct.—The concrete conduit has been finished but is still to be covered with earth for protection. This is one of the deeper cuts in rock made for this type of construction. The spot shown is along the west side of the Wallkill Valley near Lake Mohonk. About one half, or more than fifty miles, of the Catskill system is of this cut-and-cover type. The water is delivered from the great storage reservoir at Ashokan to an equalizing reservoir just north of New York City from which it enters the eighteen-mile distribution tunnel. An additional emergency reservoir north of White Plains is also supplied and retains thirty days' emergency supply

A BORING RIG FOR THE CATSKILL AQUEDUCT

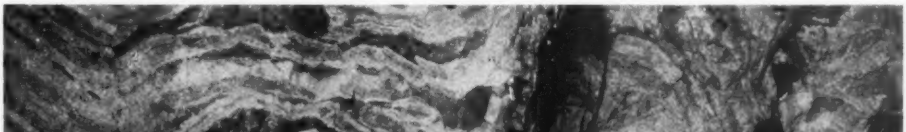
A boring rig exploring the underground conditions on Delancey Street near Allen before construction was begun. The boxes piled on the sidewalk contain drill cores taken from the rock beneath. Interpretation of these borings is depended upon to determine the conditions that will have to be met when the tunnels are constructed. The finished aqueduct passes beneath this point now at a depth of more than 700 feet below the street level

Heavy drain on this system made it necessary to build a much larger dam known as the new Croton dam, and many smaller ones for storage reservoirs in the Croton watershed. There is, however, a limit to the amount of water that can be recovered economically from a given area. To save all of the overflow in the rainy season may cost more than to secure a much larger amount by developing a new source. The capacity of the Croton watershed, it could be seen, was being approached; and even before the later developments for additional storage were completed, the city authorities were looking about

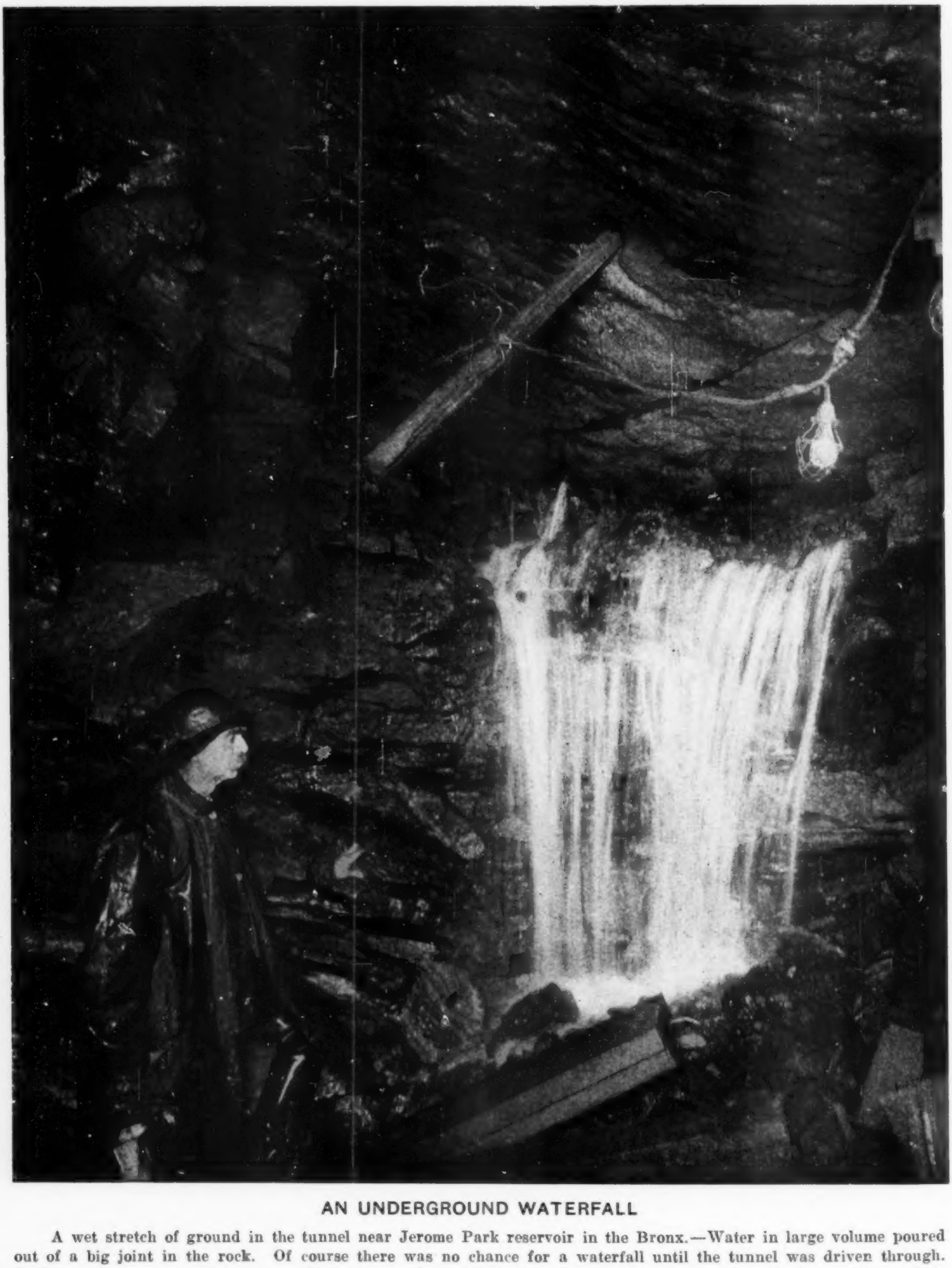
for an entirely new supply. Preliminary investigations for comparison of the advantages of different possible sources were carried out by a commission of engineers. As a result of these studies the legislature authorized development of new sources, and in 1905 the newest and most extensive of all the water projects of this or any other city was organized.

This is known as the Catskill Water Supply project. Surface waters in the heart of the Catskill Mountains are impounded and brought more than a hundred miles to New York City. The building of the great Olive Bridge dam at Ashokan on the Esopus, where the main storage reservoir with its 130 billion gallons of water is located, the construction of more than fifty miles of tunnels and an equal amount of cut-and-cover aqueduct, with an additional storage reservoir north of White Plains, holding thirty days' emergency supply, and the making of an equalizing reservoir just north of the New York City limits and an eighteen-mile distribution tunnel from that point down through the length of the city, with which the mains of the city are now connected, constituted an engineering project of mammoth proportions and difficulty. Skill of the highest order has been required in its construction, and ingenuity has been taxed to the limit in solving some of the problems.

Nearly two years were taken in exploration, planning, locating, and relocating prospective dams and tunnels and other works; but by midsummer, 1907, actual construction began. The first sod was turned by Mayor George B. McClellan, June 30, in the vicinity of Garrison in the Highlands. Since that time construction has been continuous and the major portion of the



Seven hundred feet below the boring rig.—How some of the rock looked in the tunnel beneath Delancey Street. The rock is Inwood limestone, showing complicated folding, crumpling, and faulting, and is cut through by a granite dike. This photograph was taken more than 700 feet beneath the surface of the street



AN UNDERGROUND WATERFALL

A wet stretch of ground in the tunnel near Jerome Park reservoir in the Bronx.—Water in large volume poured out of a big joint in the rock. Of course there was no chance for a waterfall until the tunnel was driven through. Such occurrences are not common. They give much trouble both in driving the tunnel and in final concreting. This is the underground water which almost everywhere fills the crevices in soil and bed rock after getting a short distance below the surface and is the supply for wells and springs. The flow is frequently very strong, and in the tunnel under Rondout Valley more than 1900 gallons of water a minute poured in through similar leaks. The water enters along joints or stratification planes or directly from the surface by way of fault planes

CRUMPLED ROCK IN THE CITY TUNNEL

The most crumpled rock encountered beneath New York City in the eighteen-mile tunnel that completes this end of the Catskill Aqueduct.—The rock is Manhattan schist, the same general type that one may see in Central Park, but this is a rare exhibit of its most complicated structural habit. All of the schist of Manhattan is characterized by remarkable crumpling folds, varying from small plications of a few inches to great arches such as form the major ridges of the island, and indicating a former deformation of the rock of considerable magnitude. Much trouble may be experienced in tunnels through folded rocks, if they show marked fracturing, and the engineers had to give careful attention in such situations to geological structure

CONSTRUCTING THE AQUEDUCT TUNNEL

More than fifty miles of such tunnels were driven through solid rock for the Catskill Aqueduct. This photograph shows the electric feed wires, ventilation pipes, water and air pipes, haulage tracks, and engineer's transit platform as they looked during the construction of the rock-tunnel type of aqueduct. In order to carry the water across valleys, tunnels were dug under them. These acted as inverted siphons which at times dropped below sea level The water was also finally delivered in the city by pressure tunnels which were placed from 250 to 700 feet below the surface in order to insure against the danger of disturbing other structures. These miles of tunnel have revealed a great variety of geological information on hitherto very imperfectly known features of the structure of New York

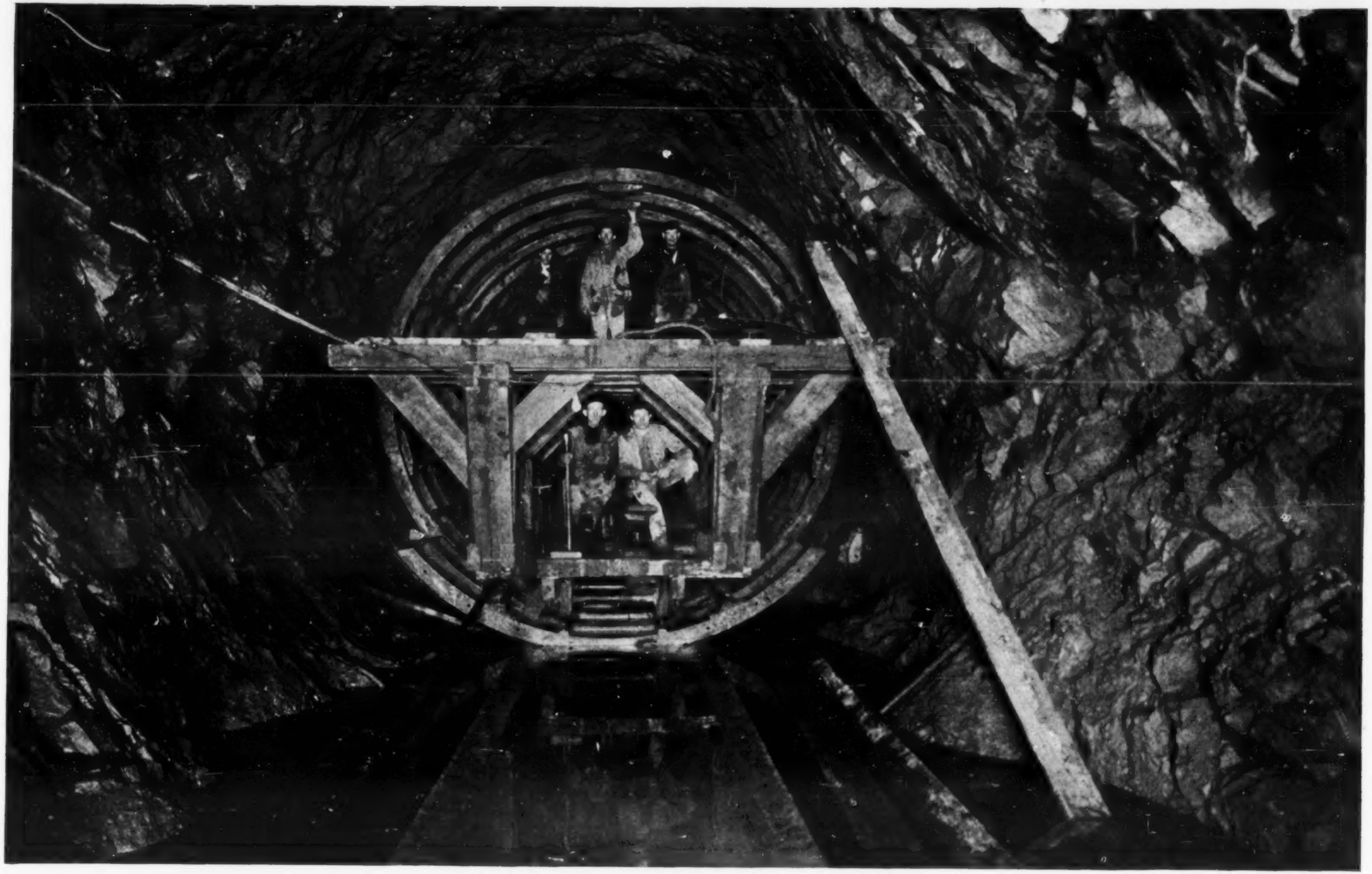
project was sufficiently completed late in 1915 to permit the delivery of water directly to the city mains.

But the finishing of its various parts and connections and extensions has continued to the present time. The last section to be added is the Schoharie supply on the north side of the Catskill divide. A great masonry dam is being built at Gilboa on Schoharie Creek that will impound the water from two hundred and fifty square miles of territory. This water is to be diverted by an eighteen-mile tunnel back through the Catskills beneath the highest mountain peaks of the range and added to the waters of the Esopus, finally reaching Ashokan reservoir, where the whole supply gathers.

To complete this last unit will take three or four years more. Altogether perhaps the whole project will have covered twenty years. When it is finished the city will be furnished perpetually with something like 500 million gallons of water a day from the heart of the Catskill Mountains, water that is so pure that neither filtering nor other treatment is necessary.

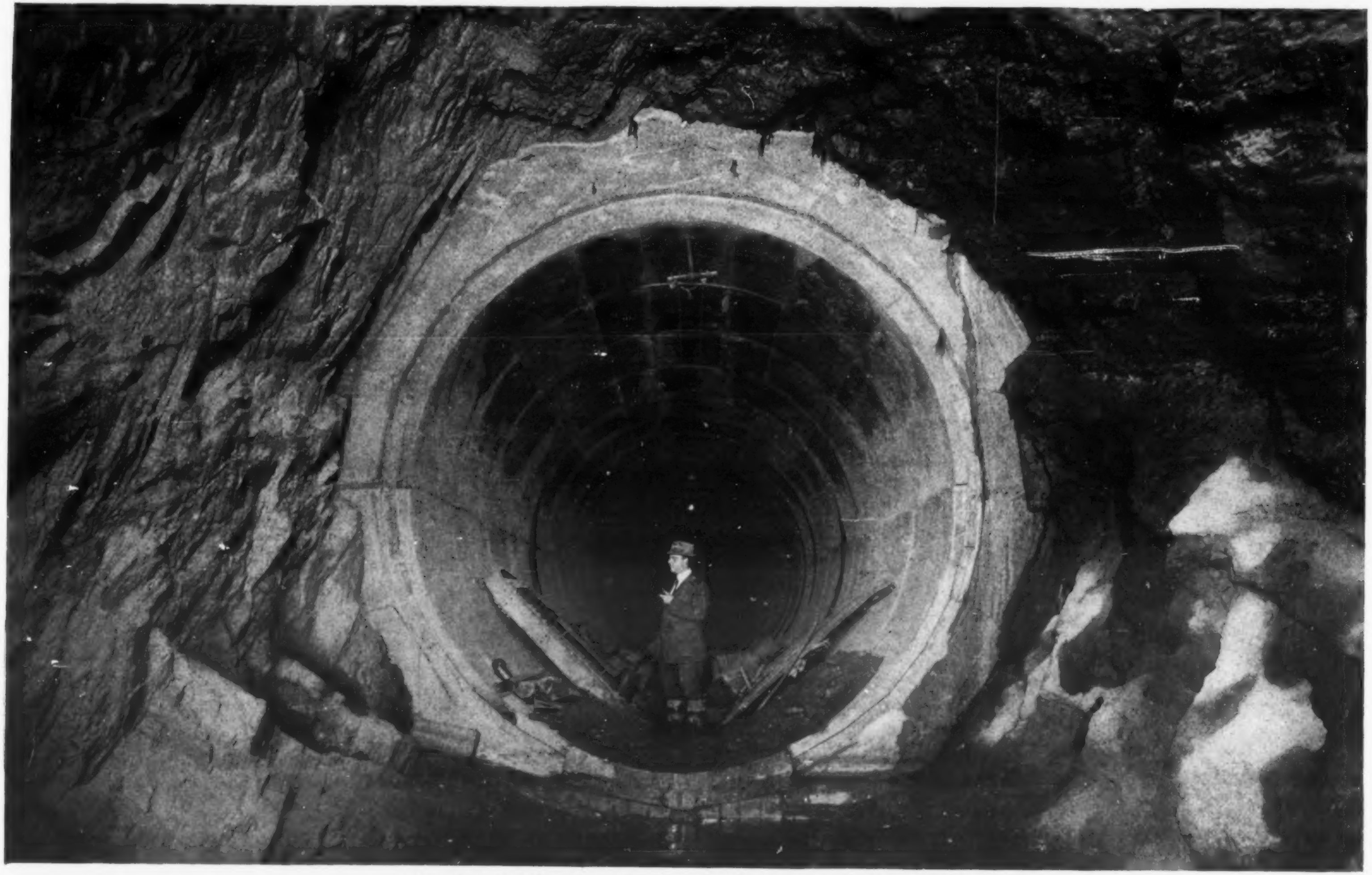
The bare figures themselves are interesting to anyone who appreciates their magnitude and significance, but, in addition, many special problems have been encountered that have an appeal of their own. The nature of some of these problems can be appreciated most readily by a little more specific explanation of the nature of the general design, the objects to be attained, and difficulties to be overcome. For example, it became necessary to construct a dam that would hold back 130 billion gallons of water without serious loss or danger of collapse. If the water leaks out the whole project is a failure or if the dam gives way the valley below will be devastated. A place must be found and a design adopted that will accomplish both ends. Thus its location or the choice of dam site is of prime importance. More than a year of exploration preceded its selection. Esopus Creek, flowing as it does in certain stretches in a narrow rock gorge, looked simple enough, but its present-day course is quite different from its ancient pre-Glacial one. Exploration showed an old channel at one side more than a hundred feet deeper than the new one, completely buried beneath the glacial drift. In most places this drift filling of the ancient gorge was itself porous and it would be leaky ground on which to locate a dam. Finally, however, at Olive Bridge it was found that the quality was dense and tight and capable of holding water. Here the dam, more than two hundred feet high, has been constructed successfully. Behind it is held in storage enough water to cover Manhattan Island to a depth of twenty-eight feet.

The water in Ashokan reservoir stands at about 590 feet above tide whereas New York City lies almost at sea level. On account of this difference of elevation it should be theoretically possible to construct an aqueduct between the Catskills and the city that would allow the water to flow by gravity in trenches or pipes and deliver itself. This looks simple enough but a little consideration of the problem shows that the Catskill supply lies on the west side of the Hudson Valley, whereas New York City lies on the east side, and to reach the city it would be necessary to cross several large tributary valleys besides the Hudson gorge itself. In addition two considerable mountain tracts, the Shawangunk range and the Highlands, have to be crossed. It is apparent, therefore, that it would not be possible to build a simple grade aqueduct but that some plan would have to be devised for crossing the valleys that are too low and penetrating the mountains that are too high without losing the head of the water. Otherwise it must all be pumped at these discordant points, thus adding to the expense of delivery.



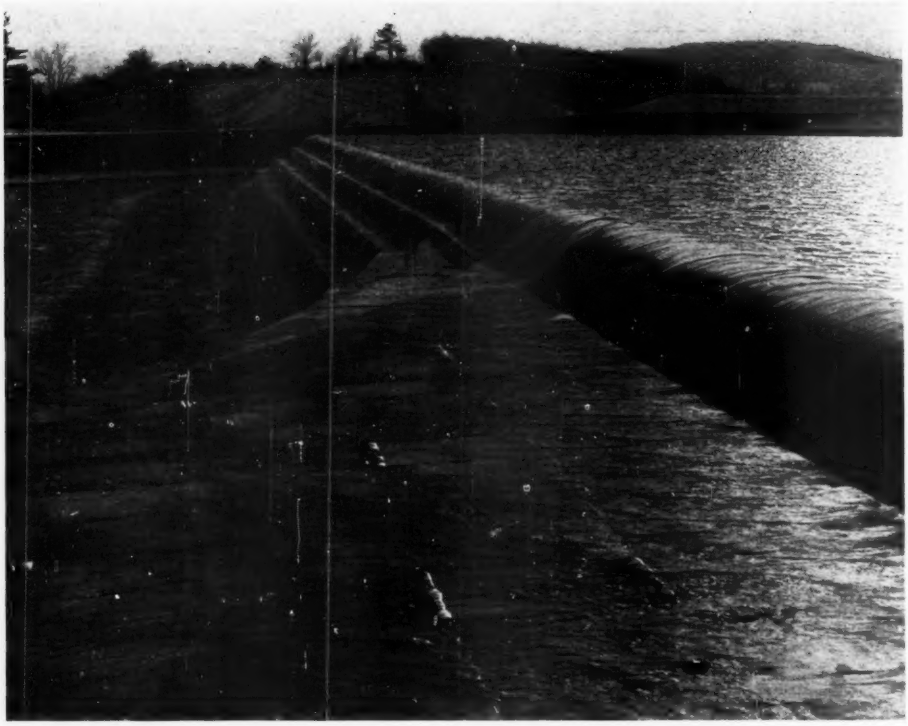
FINISHING THE PRESSURE TUNNEL AQUEDUCT

A stage in the finishing of the rock-tunnel type of aqueduct. The concrete floor ("invert") has already been laid. On it rests a removable steel framework supporting steel plates to give form to the finished structure. Cars loaded with concrete mixture are then run in on a platform and the concrete is poured over the sides, ultimately filling the entire space between the jagged rock walls and the steel frame. After the cement sets, the frame is removed and set up a little farther on and the process repeated



AN AQUEDUCT TO CARRY 500 MILLION GALLONS A DAY

The finished pressure tunnels look like this. A smooth concrete conduit carries the water. Irregularities of the rock walls of the original tunnel are all filled. Note that the imprint of the steel plates of the form, against which the concrete mixture was poured and allowed to set, can be plainly seen on the inner surface. This section is 16 feet in diameter in the clear. It is probably as nearly permanent and indestructible and safe from interference and contamination as it is possible to construct



The Spillway.—Arrangements are always made with great care for the overflow of surplus or flood waters. At certain seasons the withdrawal of water for use cannot keep pace with the supply, and unless suitable provision is made for the overflow to escape under controlled and safe conditions, it is likely to endanger the stability of other structures. This spillway is more than two miles distant from the main dam and is constructed of solid concrete and bluestone slabs. The water is carried away in a channel floored with bluestone, set on the rock ledge, escaping finally to Esopus Creek

There are several possible methods of accomplishing this result. For example, one may carry the water across on a bridge, just as the old Croton Aqueduct crosses the Harlem River on High Bridge. On account, however, of the size of the conduit required and the width and depth of some of the valleys to be crossed, this plan was not considered feasible. In the case of smaller supplies and where the valley depressions are not so deep, iron pipes are sometimes used, but no experience is available for work of such magnitude as this. It was finally decided to accomplish the same result by the construction of tunnels in bed rock beneath the valleys. Water entering on one side of a valley thus passes beneath the valley and up again to grade on the near side by its own pressure.

Wherever the country-side lies at about hydraulic grade (the level of simple surface flow) the cut-and-cover type of construction is used. This is essentially a trench, made as if the water were to flow in it as in a ditch; but the trench is concreted and enclosed so as to make a closed conduit. Intervening mountain ridges are penetrated by tunnels at grade.

The whole aqueduct, therefore, is made up chiefly of a combination of these types of construction,—the cut-and-cover aqueduct, the grade tunnel where hill or mountain rises across the course, and pressure tunnel beneath valleys and gorges. By this method the Catskill water actually delivers itself to Hill View reservoir on the north line of the city at an elevation of 295 feet above sea level. In its course it flows along valley sides and through mountain ranges at grade and beneath valleys and gorges under pressure, but its movement is steady and sure to-

ward its destination, moved by forces costing nothing for endless service.

Catskill water leaving the reservoir passes through the aëration plant and then flows for several miles in a cut-and-cover aqueduct at grade at about five hundred feet above tide. The first large problem is presented by the necessity of crossing the deep and broad Rondout valley. A tunnel beneath the valley was finally constructed, four and one-half miles long, which, to avoid bad conditions, such as buried stream gorges, underground caves, and abnormally hard rock, was placed three hundred and fifty feet below sea level. It penetrates twelve different geological formations and cuts through some of the most difficult ground encountered in the whole line. At one spot so much water poured into the tunnel that it required a pumping capacity of more than one thousand nine hundred gallons a minute to keep the tunnel clear enough for construction to proceed.

The most spectacular of these pressure tunnels is the one beneath the Hudson River. Choice of place for crossing the Hudson was a question to which much attention was given. From Storm King Mountain to Breakneck at the northern entrance to the Highlands was finally selected as the best spot because of the quality of rock at that point. When explorations were made, however, it was found practically impossible to determine by ordinary methods the depth of the gorge and consequently how deep the tunnel would have to be placed. The Hudson gorge is an ancient one that was cañon-like in its form in pre-Glacial time and has since been partly filled with glacial drift and silt. Because, also, of the depression of the continent, the river has been drowned so that sea water backs up into the Hudson valley. Borings in the middle of the river finally penetrated river silt and bowlders to a depth of 765 feet without finding the bottom of the gorge. Inclined diamond drill holes from the sides of the river, however, indicated that solid granite rock existed entirely across beneath the river at 950 feet. An additional set of borings showed that the same rock existed at 1400 feet. It was decided on this information to construct the tunnel beneath the Hudson at 1100 feet below the surface of the river. This is the deepest section on the whole Catskill Aqueduct.

The intervening country is so varied in its geological features that each succeeding section of the line has problems of its own. The aqueduct crosses the Highlands north of Peekskill, passes beneath Croton Lake reservoir, and touches Kensico reservoir north of White Plains, where thirty days' supply is held in storage.

From Hill View reservoir on the north margin of the city the water enters the so-called City Tunnel, a pressure tunnel in bed rock eighteen miles long, ending at Fort Green Park in Brooklyn. Twenty-four working shafts were used during its construction, twenty-two of which are still used to connect with the distribution conduits of the city. Because of the danger of disturbing other structures, and as a measure of safety, the tunnel is placed from two hundred and fifty to seven hundred feet below the surface, the deepest portion being on the lower side between the Bowery and the East River and across the East River to Brooklyn. In its course it penetrates a great variety of geological conditions and has exposed features that were only imperfectly known before.

The maximum supply of water is not yet available but from 250 to 300 million gallons of water a day can be furnished. As soon as the Schoharie addition is completed on the north side of the Catskills, this water added to that of the Esopus will furnish at least 500 million gallons a day. This amount doubles the water supply of the city and seems to provide for requirements for many years to come.

PANORAMA OF ASHOKAN RESERVOIR

The reservoir as a whole covers nearly thirteen square miles of surface. The photograph shows both the upper (left) and the lower (right) basins with the dividing weir. Olive Bridge dam stands at the extreme right of the upper basin. The gate chambers, aëration plant, and beginning of the aqueduct stand in the angle between the two basins at the right

THE AËRATION PLANT AT ASHOKAN

At this point the Catskill water begins its journey. The water in the reservoir stands about seventy-five feet above this battery of 1600 nozzles, and when the gates are opened, it is forced by its own pressure high into the air, where it breaks into spray and, thus mixed with air, falls back into the basin and enters the aqueduct. This is essentially a purification process. Agitation of water so as to mix with air, as in a brook, is well known to eliminate impurities with remarkable success. The aëration plant does this same thing on an immense scale

Our American Game Birds

Especially in review of "The Game Birds of California,"[1] a volume issued from the University of California Press

By FRANK M. CHAPMAN

Curator of Ornithology, American Museum of Natural History

GAME birds constitute one of our most important assets in bird life. Time was, and that not very long ago, when their value was estimated in what they would sell for as food. But necessity has broadened our vision. There has been increase in population and corresponding decrease in the area available for birds, several million sportsmen are taking the field each year, automobiles and power-boats make every corner of the country accessible, and a dozen other destructive factors are at work. It became apparent, therefore, some time ago to even the most short-sighted and selfish hunter that the game birds of the country would soon be a memory unless radical measures were taken to diminish the number legally killed each year.

Even assuming that the laws were observed, they were far from strict enough and were often made in the interest of the hunter rather than for the protection of the hunted. Sportsmen who looked to the future of sport, and ornithologists who studied the situation from a broad, scientific viewpoint, saw that there were two measures of the greatest importance to insure the continued existence of our game birds. These were, first, prohibition of their sale and, second, uniform protective laws based upon scientific principles wherein each species was considered not from a local but from a national or even international standpoint.

Under certain conditions game birds constitute a natural and proper source of food; but when the demand so far exceeds the supply that the latter is threatened with early extinction, it is obviously time to stop and take account of stock. In short, we were confronted by the old question of the goose and the golden egg. Fortunately we have decided to be content with the egg. In other words, despite the protests of game dealers, hotel and restaurant keepers, epicures and gourmands, we now consider our remaining game birds to be of more value to sportsmen than to market hunters. This decision is based on sound ethics and equally sound economics. The sums the sportsman is willing cheerfully to expend for guides, dogs, boats, transportation, board, and in the maintenance of private preserves, become, in the aggregate, an amount in comparison with which the actual food value of the game pursued is insignificant. And this is wholly aside from the pleasure and benefit derived by the sportsman in the pursuit of game. It is obviously good business, therefore, to protect a capital which pays so high a rate of interest. The sale of wild game is consequently almost universally prohibited throughout the country and game birds are thereby conserved primarily for sport instead of for food.

The elimination of the pothunter, however, by no means solved the problem of game protection. The "game-hog" still remained. But the replacement of state by federal regulations, through the passage of a treaty with Canada covering migratory birds, is a guarantee that the preservation of the birds rather than the wishes of the sportsman will be given first considera-

[1] *The Game Birds of California.* By Joseph Grinnell, Harold Child Bryant, and Tracy Irwin Storer. Contribution from the University of California; Museum of Vertebrate Zoölogy. University of California Press, Berkeley, 1918. Royal 8vo, 642 pages, 16 colored plates, 94 figs.

From the painting by Louis Agassiz Fuertes

THE MOUNTAIN AND CALIFORNIA QUAILS

The former (at the left) indentified by its large size and exquisite coloring, is the most beautiful quail known; its small numbers and the mountainous habitat limit its use as a game bird. It is conceded that the California quail, together with its subspecies, the valley quail (*Lophortyx californica vallicola*) is California's finest game bird. California and valley quails have been introduced successfully into other western states but do not thrive in the East—any more than our bobwhite thrives when transplanted to California. Fortunately, it is illegal to sell quail of any species in California except for propagation and then only under permit. What is needed for the beautiful mountain quail of California—and for our eastern bobwhite in many localities—is a complete close season for several years until the species recuperate

tion; moreover, the limits placed on the number of birds which may legally be killed in a day acts as a further curb on the thoughtless or selfish hunter.

The backbone of this movement, which has occupied the attention of conservationists for years, is public sentiment based on a knowledge of the innumerable facts involved. It was only when the public was sufficiently impressed with the urgent need for stricter game laws, if our game birds were to be saved from extinction, that the passage *and enforcement* of such laws became possible.

This campaign of education has been conducted by the Audubon Societies, Game Protective Associations, Federal and State governments, and other educational agencies, largely through the issuance of informative publications. One of the most noteworthy volumes among such publications which have thus far appeared is *The Game Birds of California*. Convinced by extended field work that the game birds and mammals of the state were rapidly decreasing, the staff of the Museum of Vertebrate Zoölogy, of the University of California, decided that in order to make the game laws effective "the people at large must be apprised of the facts and shown the need for, as well as most effective means of, conserving our game resources." Thanks to friends of the Museum interested in the protection of wild life, funds were provided which made possible the production of this admirable volume.

Introductory chapters treat of the "Decrease of Game and its Causes," "The Natural Enemies of Game Birds," "The Propagation of Game Birds," and kindred subjects. The greater part of the volume, however, is devoted to detailed biographies of the game birds themselves; that is, of California waterfowl and shore birds (snipes, plovers, etc.), quail and grouse, pigeons and doves. The roseate spoonbill, wood ibis, and white-faced glossy ibis also are included, although these birds are not commonly ranked as game.

Full biographies record what is known of the life history of each species and a wealth of data concerning its present and past status in California is given. With those birds which have been most hunted the story is invariably one of wholesale slaughter and rapid decrease.

It is estimated, for example, that 250,000 ducks were sold in San Francisco markets in the season of 1911–12, but in 1915–16 the number had fallen to 75,000. In 1909–10 one transfer company in San Francisco sold more than 20,000 geese, and the rate of destruction indicated by these figures was continued until the birds became comparatively rare. It is not alone statistics of this kind in which the volume abounds but also authoritative accounts of the habits of the birds monographed which should arouse a keen interest in them and hence in their continued existence.

The book makes a further appeal through its well-produced colored illustrations by Louis Agassiz Fuertes and Allan Brooks, as well as by an attractive format.

The authors are scientists, not sportsmen, and they handle their subject from the standpoint of ornithologists rather than from that of the hunter. The book, therefore, is lacking in descriptions of methods of killing birds and stories of the hunt, and the end its authors have in view will probably be better served by the omission of matter of this kind. But, in the reviewer's opinion, its message would have been stronger if it had dwelt with greater emphasis on the value of game birds as a bond between those who pursue them and the marshes, fields, and forests in which they live.

Caiman Hunting in South America

By ALBERT M. REESE

Professor of Zoölogy, West Virginia State University

IT was the writer's privilege to spend a recent summer at the Tropical Research Station of the New York Zoölogical Society in British Guiana, the main object of the expedition being to collect embryological material of the caiman for researches under the auspices of the Carnegie Institution.

While the caimans, according to Beebe,[1] are the only crocodilians represented in British Guiana, at least four species of the genus are found there, the largest of which is the huge, supposedly man-eating black caiman, *Caiman niger,* confined apparently to the upper reaches of the rivers at some distance from the coast. In the region of the station, about fifty miles inland, caimans are very scarce; the only one seen during the summer was a small one killed by the Indian hunters employed by the station.

Along the coast, especially in the region of the Abary River, in the eastern part of the colony, the smaller species of caiman, rarely reaching a length of seven feet, are so abundant that they may frequently be seen from the car windows of the trains of the Demerara Railroad as these pass over the swamps and rivers.

Crocodilians are hunted for various reasons. In Florida the alligator is, or was, hunted chiefly for sport, and for its hide when alligator leather was in vogue. The caiman, since its hide is too heavy and osseous to be useful as leather, is hunted mainly for the sake of its eggs. This source of danger to the caiman, however, is but slight, as the haunts of this species are off the line, somewhat, of the sportsman-tourist routes. The eggs are collected by the natives for two reasons: first, for the purpose of hatching them under artificial conditions to obtain young animals for stuffing as souvenirs; second, merely to reduce the number of caimans—or "alligators," as they are commonly called—which the planters consider a pest on the sugar and rice estates, although the economic status is probably not at all certain. It was the eggs that the writer was particularly anxious to obtain, although he was also much interested in the general habits of the animals.

As in the case of the writer's previous experiences in the search for alligator eggs in Florida, the first thing to do was to find a native hunter to act as guide and bureau of information, although the information obtained from such people is usually anything but reliable. In Florida, years ago, the best known 'gator hunter was probably Alligator Joe, of Palm Beach. The "Alligator Joe" of Georgetown is a tall gentleman of Ethiopian extraction known as "Professor Pile," who is considered the local authority on all matters relating to "alligators." A meeting was promptly arranged with the "professor," who agreed, at the end of a week's engagement which he then had, to locate all the nests needed to obtain the desired embryological material. He was evidently anxious to collect the eggs himself, rather than to act as guide to locate the nests, and the dangers and trials of hunting 'gator nests were depicted in as terrifying terms as possible. Having had much more extensive experience with the *Crocodilia* than the professor realized, the writer insisted that he was looking for a guide rather than a collector, and arrangements were made for a two-days' trip to a famous collecting ground within easy reach of Georgetown. As a last, but by no means least, preliminary the guide was asked his charges. "Forty dollars a day and expenses," was the modest reply. Diplomatic relations were severed

[1] *Zoologica*, Vol. II, Nos. 7, 8, 9, p. 211, 1919.

on the spot and another guide, perhaps less famous, was secured at three dollars a day. With this man, and later, with a gentle-mannered young East Indian named Perong (nearly all of the labor of this British colony is performed by men and women imported from India), the canals and ponds in the region of Georgetown were explored in a search for the not very numerous caiman nests.

After I had learned the general lay of the land, the services of the guides were often dispensed with; but when it was necessary to wade across some muddy canal or pond, through flags and other water plants, sometimes neck-deep, with a "cutlass" (the universal implement of the coolies, corresponding to the "bolo" of the Philippines and the "machete" of Cuba) as the only weapon in case of attack by some caiman mother, the absence of the guide was not always to be desired. Professor Pile's harrowing stories to the contrary, however, no indication of aggressiveness by the animals whose nests were being robbed was ever seen, in which the caimans resembled their mild cousins of Florida, the Mississippi alligators.

Some of the pleasantest expeditions were those taken with Perong, who lived in the village of Peters Hall and worked on one of the huge sugar estates which are the chief industry of the colony. In his slender dugout in one or another of the large irrigation canals that parallel each other at short intervals across the sugar estates, we paddled or poled, according to the depth of the water, going about on these grassy waterways with considerably more comfort than was possible in walking beneath the tropical sun that at midday cast a very short shadow toward the south. Perong's English vocabulary was rather slight, but we managed to understand each other and his knowledge of the language of the coolies enabled us to make inquiries about the location of nests.

One of the first nests located by Perong was a small one so low and flat that it looked like an abandoned nest of some past year. On digging into it with a cutlass, we found it contained twenty-three eggs with well-advanced living embryos in them. As in

The Tropical Research Station of the New York Zoölogical Society, Katabo Point, British Guiana (seen from the Mazaruni River)

Perong, the East Indian guide, with his dugout, in one of the sugar estate irrigation canals.

Caiman's nest (lower picture) beside an irrigation canal and exposed to the full force of the sun

Mr. Gordon and three coolies, with trophies of the caiman hunt

the case of the alligator, the nests of the caiman differ widely in size and appearance. The one shown among the illustrations was, like those of the alligator, built of the flags and grasses growing in that vicinity and was in the open, exposed to the full fury of the tropical sun. Many caiman nests, however, are built of a mass of fine vegetation and dirt, scraped up from the ground. Such a nest we found located beneath a thick mass of bushes, where the direct rays of the sun could seldom, if ever, reach it. A similar shaded location for a nest was on the shore of one of the ponds in the Botanical Gardens of Georgetown. In these ponds caimans are found, and they build their nests in the bamboo thickets. When lying quietly in the water among the victoria regias, the caiman's protective coloration is so perfect that only a keen eye can locate the animal, which usually sinks quietly beneath the brown water before a shot at it is possible.

Such bamboo thickets serve as nesting places for countless birds—herons and the like—and it is probable that the young birds furnish an abundant supply of food to the caimans that lurk in the waters beneath.

Not having secured all the material desired in the vicinity of Georgetown, I decided to visit the eastern part of the colony, in the region of the Berbice and Abary rivers, where, it was said, "alligators" were much more numerous. On writing for information at the suggestion of a mutual acquaintance to Mr. J. R. C. Gordon, the manager of the well-known Blairmont Sugar Estate, I received a very cordial invitation from this courteous English gentleman to be his guest and use his house as a starting point in the search for caiman nests.

Hunting alligators with Mr. Gordon, who decided to take a short holiday and go along, proved to be hunting *de luxe*. Instead of a dugout and paddles for two, we two Anglo-Saxons had a boat with a comfortable seat, one coolie to steer and three others to serve as motive power by dragging the boat by means of a long rope from the towpath of the canal. In this luxurious manner we followed the canal for ten miles or more to our destination on the Abary River. Along this canal were seen various birds, among them numerous hoatzins or Canje pheasants, those curious birds with persistent reptilian characteristics, so interestingly described by Beebe.[1] On reaching the end of this stage of our journey we found another boat that had preceded

[1] *Zoologica*, Scientific Contributions of the New York Zoölogical Society, "A Contribution to the Ecology of the Adult Hoatzin." Vol. I, No. 2, pp. 45–66, Dec., 1909. Also *Tropical Wild Life in British Guiana*. By Beebe, Hartley, and Howes. Vol. I, pp. 155–82, 1917. Also NATURAL HISTORY, "The Hoatzin—Only Survivor of an Ancient Order of Four-footed Birds." By Edward M. Brigham. February, 1919, pp. 163–69.

us, with provisions, mosquito nets, and numerous coolies to administer to our needs. Altogether there were thirteen East Indian coolies to take care of two perfectly healthy Anglo-Saxons.

At the Abary River we embarked for a short journey down that narrow but deep stream. Our vessel was the "Creation." On the great sugar estates the cane, which is very heavy, is hauled to the factories usually in steel barges, the motive power being horses or mules. The banks of the Abary are unsuited for a towpath, so Mr. Gordon had built this unique motor-boat, which he christened the "Creation." It was simply a rough boat in which he had installed a topless and wheelless Ford c , the rear axle geared to the stern paddle wheel and the steering gear connected with the rudder. A small Negro boy served as chauffeur to this hydro-Ford and we sat in the shade and motored up and down the Abary in the utmost comfort.

Along the irrigation canals leading from the Abary caimans were found in considerable numbers even at this wet season, when the "savannahs" or plains were covered with two feet or more of water. On the banks or "dams" that confined the water numerous caiman nests were found, usually containing about twenty-five eggs each. Several of the caimans were killed as a part of the work of the expedition and their skulls or entire skeletons "roughed up" for the American Museum of Natural History. In cleaning the flesh from the bones advantage was taken of the aid of the buzzards and carrion crows, as had been done on other similar trips. The skins were removed and the carcasses were left exposed to the attack of these vultures, which soon cleaned the bones sufficiently for transportation.

It was most interesting to note the way in which the birds dropped from an apparently empty sky. It was two hours after the carcasses had been exposed before the first buzzard discovered them and made a wary survey of conditions; but in twenty-five minutes from the time that this first bird had begun to feed, sixty-five buzzards and carrion crows had dropped from the cloudless sky to hiss and fight over the bones,—which were pretty well cleaned of flesh at the end of that time. How many more birds would have arrived had the supply of food lasted it is hard to guess. It was fascinating and mysterious to see these great birds suddenly appear from nowhere.

While the rainy season of late spring and early summer is the time to hunt the recently laid eggs, the dry season is the time to study the caimans themselves, when the savannahs are dry and the animals are concentrated in great numbers along the canals and other water courses.

It would seem well worth while to study the habits of these "alligators" in British Guiana, especially as to their food, since it is likely that they may serve a useful purpose in the United States by destroying cane rats and other pests, as is the case with *Crocodilia* in other parts of the world.

The "Creation," a homemade motor-boat used for towing barges of sugar cane. The motive power is a topless and wheelless Ford car

The Discovery of the Chinese Takin

By MALCOLM PLAYFAIR ANDERSON

Professor Melville B. Anderson, of Leland Stanford Junior University, father of the late Malcolm P. Anderson, has placed the following manuscript by his son for publication in the columns of this magazine. The Chinese story by the same author in the January–February number was staged near the sacred mountain, Tai-pei-san, of 12,000 feet elevation, which forms the scene of the present hunting experience.—THE EDITOR.

I

THE takin, an animal nearly the size of a steer and perhaps related to the musk ox, has long been known from the mountains of southeastern Tibet, and another race from extreme western China. In 1910, while conducting the Duke of Bedford's Expedition, the author had the good fortune to discover a third species[1] in the mountains of northern China. As very little is known of the habits of any species of this animal, it seems worth while to put the experiences on record.

The precise locality of the discovery is on the heights of the sacred mountain called Tai-pei-san, rising to an altitude of more than twelve thousand feet in the Chin-ling range of the southwestern portion of the Province of Shensi. Tai-pei-san is not a mere peak but a group of summits, the ridges of which rise very steeply to form the isolated mountain mass, apparently much higher than other portions of the range. High up on this eminence exists a belt or zone of bamboo grass, the habitat of the takin.

The late Malcolm Playfair Anderson, leader of the Duke of Bedford's Asiatic Expedition of 1910; he discovered a species of Chinese takin on the heights of the sacred mountain, Tai-pei-san

With my companions, Smith and Ward, I had been staying awhile at the village of Ling-tai-miao, which lies in a cañon west of the great mountain. While engaged here in studying the birds and mammals of the vicinity, we heard reports from the natives of a strange animal called by them "pan-yang." Being too busy to search for the beast, we hired a hunter to shoot some specimens, stipulating that he should send notice promptly so that we might go out and skin the animals. One evening a messenger arrived with the news that two females had been shot. He said that the kill was near by and urged us to start at once for the mountain. As it was late and cold, I decided to wait until morning, and this was wise for, as will be seen, the carcasses lay on the other side of the mountain, where they could be reached only by dint of ten hours of the hardest climbing.

The next morning, guided by the

[1] *Budorcas Bedfordi*, described by Mr. Oldfield Thomas in Abstr. P.Z.S. 1911, p. 27 (May 2), and in *Proceedings of the Zoological Society of London*, pp. 693-95, from the specimens discovered by Mr. Anderson.

messenger, we all set forth, starting from the cañon bottom at an altitude of about three thousand feet, whence we ascended a grassy ridge intervening between the village and the lofty peaks, crossing a valley of considerable depth.

Then began the actual climb. The track followed was more a slide for timber than a trail and ran straight up the abrupt slope. Yet this was not so bad as long as we were on the bare frozen ground, but, upon reaching the snow in the forest, we found the trail all icy so that climbing in ordinary hobnailed footwear was next to impossible. This contingency having been foreseen, we now bound upon our feet some heavy iron spikes, a Chinese contrivance for the purpose, made for us by the village blacksmith.

There was no slackening of the slope until near the summit. We moved slowly but rose very rapidly, first through woods of small oak, then through the forest of spruce where there was varied undergrowth of bushes. Higher up, the bushes gave place to a thicket of small bamboo, called "bamboo grass," growing from six to twelve feet tall and as thick as it could stand. So dense was the thicket that it was impossible, going up, to force one's way through it; descending, one might ride it down, but only with great effort. Higher still, the spruce forest was filled with rhododendron and azalea bushes. Finally, leaving this below us, we came out on the mountain tops where the few trees and bushes were stunted.

During the latter part of the climb we all felt the effects of the altitude; Ward especially showed signs of fatigue and fell behind several times before we reached the lofty pass that had to be crossed. We waited in the divide until we saw him safely at the highest point, together with the man and the boy who carried our food; then, thinking all was right and that Ward would follow us without further difficulty, Smith and I went ahead, not suspecting that the carrier did not know the way.

Beyond the pass we descended over long stretches of talus till we reached the forest and the upper edge of the belt of bamboo grass again, at an altitude of about ten thousand feet. It was already twilight when we reached the camp of some coffin-board cutters, where we found our hunter awaiting us.

Tired and hungry, we watched for Ward and our provisions, but darkness fell and they did not arrive. I was for starting out to look for the stragglers, but Smith suggested that it would be useless and, on second thought, it occurred to me that our companion, having all the food, would be likely to fare better than we ourselves.

The sawyers had built a narrow little shelter by leaning some boards against the side of a cliff, and here a number of them were crowded about a scanty fire. In this poor, fragile cabin room was made for us, and we sat awhile, partaking, gladly enough, of some of the corn cake on which these wretched creatures live and which they were toasting in the ashes. Luckily we had our small blankets, so presently we went out under the stars in search of a place to sleep. The mountain-side being very steep, it was not easy in the dark to find a level spot, but at last we settled down. It was very cold on the frozen ground from which Smith and I made shift to scrape away the snow, and we lay shivering all night.

In the morning we were anxious to see the animals we had come so far to skin. Expecting that Ward would arrive in our absence, we left directions for him to follow, and set forth, without a morsel to eat, on what proved to be a long task. In the bamboo thicket below the sawyers' camp, on a very steep slope leading down to a frozen torrent, we found the first takin. I had thought it likely that I would know

the animal when I saw it, but in this I was mistaken. Smith said it was a musk ox, but I knew better than that. We named it the "goat ox." It was a full-grown female of light sandy color all over, and of a size similar to that of a domestic cow, though much shorter in the legs and with a decided hump of the shoulders. The horns at once excited our curiosity,—these it was that had reminded us of the musk ox. They were not very long, arose close together from the brow, ran outward and downward for about eight inches, then turned sharply upward and backward. The tail is like that of a goat, short and bare on the under side. I noted especially that the side or false hoofs of all four feet were particularly large and well worn, as if they were useful to the animal. Probably this four-hoofed foot gives a good grip on rock surfaces, making it possible for the beast to traverse the precipitous places which it inhabits.

As has been stated, the takin frequents the thicket of "bamboo grass" on the leaves and shoots of which it feeds. Below this belt it does not descend, but frequently comes out upon the crags above the bamboo to browse the bunch grass that grows abundantly there. For an animal of such bulk and apparent unwieldiness, it is exceedingly swift and nimble in climbing over the rocks.

To skin such a large animal on the steep slope was a difficult matter, but we cut away the thicket to give us room and built a staging of poles out from the mountain-side for the carcass to rest upon. As it had frozen stiff, the task of removing the skin was far from easy. Into that deep, cold cañon the sun did not penetrate all that day. We finished skinning the first carcass about noon, when we turned it over to the Chinese woodcutters, who eagerly set about carving it up, saving all the blood and even the entrails, which they seemed to value more than they did the flesh.

As the second carcass lay upon an even worse slope where we had difficulty in keeping our foothold, we were obliged, at the risk of injuring the skin, to drag it down some distance until we had it securely at rest upon the upper side of a large spruce log. This was a very inconvenient place in which to work, and what with this and our fatigue and hunger and the intense cold, our progress was slow. The frozen flesh stiffened our fingers until we could not handle the knife, so that we had to stop frequently and thaw out our hands by a little fire we had kindled. By the time we had finished, the pale, wintry sunshine had faded from the cliffs above us.

Now arose the question whether we should remain another night or return at once to Ling-tai-miao. The Chinese thought us mad to talk of returning, and indeed the project was rather foolhardy, but, besides being famished, I was anxious to learn, if possible, what had become of Ward. We therefore decided to return.

Arrangements were made with the hunter to bring down the skins and skulls on the morrow, so we had nothing to carry with us but our roll of blankets. The coolie who had brought this up refused to accompany us back that night, but our chief muleteer, who had followed us up from the village, volunteered to take his place. Darkness was falling when we started up the talus slopes leading to the high pass; nor had we gone far when the muleteer found his burden too heavy. As I was more used to such a load than he was, he and I agreed, from that point on, to carry the pack by turns.

When my little party reached the divide, a very high wind struck us in the face with such force and so icily that we could hardly make headway. But we crept along from sheltering rock to rock as best we could and so

arrived finally on a flank of the mountain where we were more shielded.

Meanwhile the full moon had risen high, lighting up from a clear sky such a scene as we had never looked upon before. To right and left rose snowy peaks, at our feet was a precipice, and far below us lay vast cañons filled with dark forest. By daylight it would not have appeared an unusual mountain scene, but in this enchanted light it was indescribably majestic. We paused awhile, forgetting that we were tired, shivering, and famished.

At midnight we two entered our inn at the village and were relieved to find Ward in his bed. He also had had a hard time, for the porters had been unable to find the way, and had wandered off down some spur of the mountain. At night they had found a place somewhat sheltered from the wind and had built a fire. Then the Chinese, opening the bag of provisions, had offered Ward bread, but he, not understanding them, and not knowing that the food was ours, was too proud to accept. So he too had gone hungry, although watching the men eat his own provisions.

II

On another occasion I became more closely acquainted with the takin of Tai-pei-san.

My friends and I decided to hunt the animal ourselves. As it was the coldest part of the winter, we made careful preparations. Hiring two native hunters as guides, and some other men to carry our blankets and supplies, we started out for a stay of several days.

On the morning of January 8 we began the ascent, following the trail as before, and it was near nightfall when we reached a point near the upper edge of the belt of bamboo grass. We had brought no tent because our chief hunter, Yang, had told us of a cave that we could camp in. This, however, proved to be, instead of the real cavern we had expected, merely an overhanging cliff affording no very good shelter. It was at the head of a deep and narrow cañon at an altitude of ten thousand feet in the spruce forest and surrounded by the thick undergrowth of bamboo.

In this shelter, such as it was, my friends and I took the part next the wall of rock, while the Chinamen built a large fire near the outer edge. Wrapping ourselves in sheepskin robes we spent the night in our blankets—but the men sat all night by the fire, dozing and talking at intervals. So they passed not only this first night but all the nights we remained there. On our previous expedition we had observed that the poor coffin-cutters passed their nights in the same way, their narrow shelter of boards giving them no place to lie down. It was a wonder to us that they should be able to do what they did on so little sleep. Reflection upon what we observed led us to the conclusion that their fatigue was merely muscular, rather than mental or nervous, and that they could rest standing, if necessary, like so many horses.

We awoke in the morning to find ourselves surrounded by a thick fog, while a light snow was falling. As our hunters assured us that it was useless and dangerous to go out, we remained near the shelter all day, preparing the skins of a few mammals we had trapped during the night. Toward evening, as the fog began to thin, Smith and I, feeling the need of exercise, climbed a thousand feet farther up the mountain. Getting out of the fog for a time, we were rewarded for our exertions by magnificent views of valleys below us and of various spurs and ranges standing out of the enveloping mist and bright in the setting sun.

The third day was far better, the sky being clear and the fog lying sea-like thousands of feet below us. The flanks of Tai-pei-san formed a rugged coast line which, from our lofty point

of vantage, the eye could follow into the distance. Few other mountains of our range were of sufficient elevation to appear, although, far beyond, peaks stood above the clouds. Observing this, we were impressed with a sense of the distance by which Tai-pei is separated from the heights to the westward.

We had intended to begin our search by early dawn, but Yang and his men were slow in getting started. This made us restless, not yet knowing, as he did, that the takin is a diurnal animal. At last we made our way up the rocky slopes to a saddle which, as my barometer told me, had an elevation of twelve thousand feet and upward. Here among the rhododendron bushes above the zone of bamboo the hunters laid down their matchlocks side by side, and Yang prepared to pray to his ancestral spirits and to the God of the Mountain. First lighting several sticks of incense and sticking them up in the snow, he burned a sheet of yellow paper beside them. In his prayer, which was long, he told the spirits all about us and our hunting trip, and how he had brought us there to hunt the pan-yang, and he prayed that we might speedily find those animals. After the prayer he spent a long time in repeatedly tossing up two pieces of wood, evidently desiring to work some charm. These blocks were horn-shaped, flattened on one side, ridged and grooved to fit together; apparently he would not be satisfied until they fell in a particular way. He would try and try, then pray awhile and try again; then he would work a little over the guns, change their positions, and try once more. If his perseverance was rewarded with success there was no sign of it from him or his men. At last, when our patience was nearly exhausted, Yang pocketed the sticks and rose from his squatting position, took each gun in turn, passed it first under one leg, then under the other, and handed it back to the owner. Then they were ready to hunt.

While two of the hunters went down one side of the divide, my companions and I followed Yang down the big ridge through the forest and over rocks and ledges, finally reaching a projecting cliff from which was an outlook in several directions. From this point, after a careful scrutiny of the mountain-sides, we at last caught sight of the game. Deep down below us, feeding among rocks and precipices, was a whole herd looking like a herd of cattle.

I was for stalking them at once, but Yang wished the other two men to participate and I yielded to him. So we made a long detour to the other side of the ridge and, after much whistling, our signals were answered from far below. When, on the arrival of the other fellows, I learned that they had been on the track of a goral, I wished that we had left them alone. The greater

Bedford's Chinese takin, discovered by Mr. Malcolm P. Anderson in 1910, on the heights of Tai-pei-san, northern China. From a drawing in color by H. Goodchild in *Proceedings of the Zoological Society of London*, Vol. II, 1911

part of the day had passed and we had done nothing more than locate our game. Crossing back to the point whence we had seen the herd, I took advantage of a few minutes' rest to question Yang about the habits of the takin. According to him they always go in herds; this herd, he said, contained about forty individuals. When alarmed they will stampede, always running down the mountain, but if prevented from doing this they will charge the hunter and prove very dangerous.

After a long and difficult descent across rock slides where it was hard to keep from setting stones in motion, thus alarming our game, we at length reached the spur where the herd was feeding. It was just a short, forested shoulder terminating in rocks and spires, and dropping off in a great precipice.

We had not seen all the animals from above. Just as Yang had told us, there was a large herd of these sandy-hued cattle browsing the bunch grass which grows among the crags. They were so big and seemed so clumsy that it was astonishing to find them there in a situation apparently better suited to the chamois or the mountain goat.

First cautioning us not to get into a position where we might be charged, Yang led his men off in one direction, while Smith and Ward followed me in another. We advanced, creeping behind rocks and trees, following around the face of a steep cliff until we reached a rock beyond which we could not go without alarming the game. Peering cautiously over this rock, I saw the heads of several animals which were quietly feeding not far away, but I did not choose to shoot at the heads because I wished to preserve the skulls intact. Ward and Smith, who were not armed for such large game, stood behind whispering to me to shoot. I think the takin must have heard their voices; at any rate, while I was waiting for the shot I wanted, the animals grew restless and alert. Fearing, therefore, that they would escape me altogether, I at last fired at the largest one, intending to break his spine; but I must have shot high.

At this the herd stampeded. Most of them disappeared down slopes invisible to us, but to our surprise some of them ran down the steep slope of huge broken rocks which lay in front of us, displaying an agility not to be expected in a beast so ungainly. As they bounded from rock to rock I shot four times at them without effect. Then, seeing a large bull running down the cañon to my left, I shot again, whereat he turned a double somersault down the steep. But in a trice he was on his feet again and running. We leaped down the talus slope and followed, thinking to come across his body at any moment, but found nothing, although we searched long. We climbed back to where he had rolled, finding the broken bushes and plowed up stones, earth, and snow, but no bloodstains. Amid so many crossing tracks it was impossible to follow any one.

We took our way back to camp, dejected, but before reaching it we heard a shot followed by a great shout. An hour or so later our hunter made his way up the cañon to camp to announce that he had followed a large bull to a point in the bamboo thicket below the "cave," and there had killed him with one shot.

The game was secured. With his homemade matchlock the native huntsman had outdone me and my high-powered rifle.

Mammal Fur Under the Microscope

The remarkable structural forms seen in the hair shafts of animals.—A department of knowledge not alone of zoölogical significance, but applicable also for standardizing furs and fabrics in the industries

By LEON AUGUSTUS HAUSMAN

Cornell University Zoölogical Laboratory

THE microscopic units in the structure of the hair of the various species of mammals present a multitudinous array of diverse forms. These microscopic structures in the hair shaft are so constant in form and in relationship among species and groups, that an accurate knowledge of them and of their interrelationships may contribute toward the solution of many problems, not only in pure zoölogical science, but also in the fields of certain important industries in which animal hairs are employed.[1]

What are the separate structures, so minute that the unaided eye cannot detect them, that go to make up a hair? The early writers and investigators supposed that the hair was a solid, horny cylinder, transparent, or at least translucent, throughout its length, and devoid of any definite internal structure. From a study of the hair today, with our powerful microscopes and modern microscopical equipment, we are able to determine with accuracy that each hair is a complex structure, and made up of well-defined elements.

The Life Story of a Hair

The hair begins its growth as a localized increase in the number of cells of the outermost layer of the skin, the layer called the epidermis, forming a dense aggregation of cells which elongates downward into the true skin or dermis beneath (see illustration of hair in its natural position as when growing in the skin, page 436). Directly beneath this downward-elongating depression of the cells of the epidermis there is formed a dense mass composed of the cells of the dermis, which ultimately becomes the papilla of the hair. The flask-shaped depression becomes lined with cells from the epidermis, and is known as the follicle. All future growth of the hair is confined to the bulbous lower portion of the shaft, where the conversion of cells of the follicle into horny hair-shaft cells is continually in progress during the lifetime of the hair.

Mammal hairs are in general either circular or elliptical in cross section. Those which are circular are straight or but slightly curved, while those of elliptical cross section are curly or kinky, the amount of curl being dependent upon the flatness of the ellipse.

The General Structure of the Hair Shaft

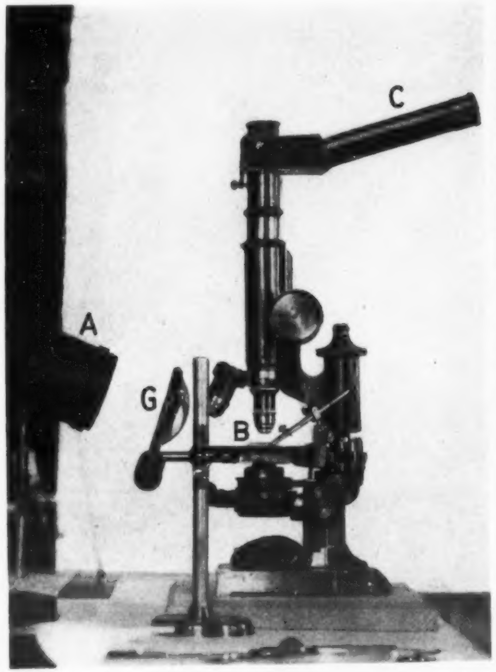
The hair shaft itself is built up of four well-defined structural units (see illustration of greatly magnified hair, page 436):

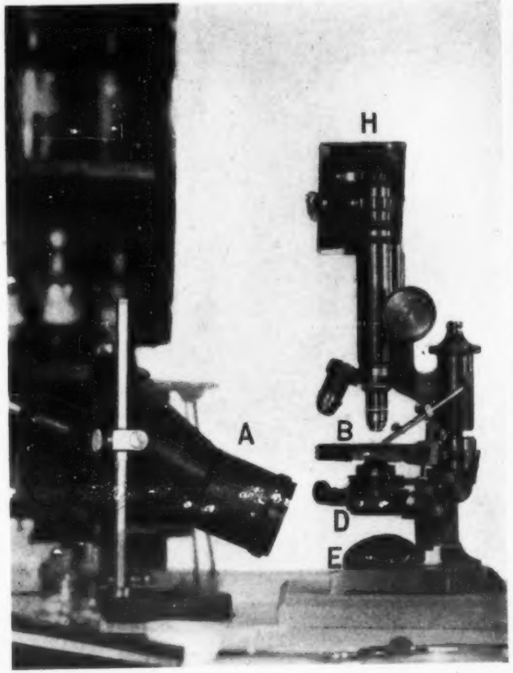
(1) The *medulla* or pith, which is composed of many shrunken and variously disposed cells or chambers, representing dried and horny epithelial structures, and often connected by a filamentous network, which may either completely or only partly fill the medullary column.

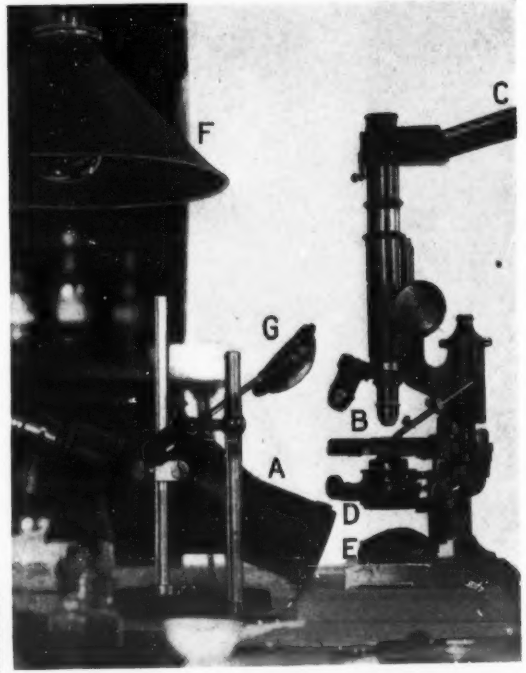
(2) The *cortex,* surrounding the medulla, and composed of spindle-shaped cells, coalesced into a horny, almost homogeneous, transparent mass, and forming, in those hairs wherein the medullary element is reduced, a large proportion of the hair shaft.

(3) The *pigment granules,* to which the color of the hair is primarily due. In some cases, however, the coloring matter of the hair shaft is diffuse and not granular in form, but in the hair of the greater number of mammals the color results from the distribution within and among the cells of the

[1] For the industrial applications of the study of mammal hairs, see: Hausman, L. A., "The Microscopic Identification of Commercial Fur Hairs," *Scientific Monthly,* Jan., 1920; "Structural Characteristics of the Hairs of Mammals," *Am. Naturalist,* in press. "Hairs That Make Fabrics," *Scientific American,* Feb. 21, 1920; "Fabrics Under the Microscope," *ibidem,* in press; "The Detection of Imitation Furs," *ibidem,* in press.







THE AUTHOR'S EQUIPMENT FOR STUDY OF MAMMAL HAIRS

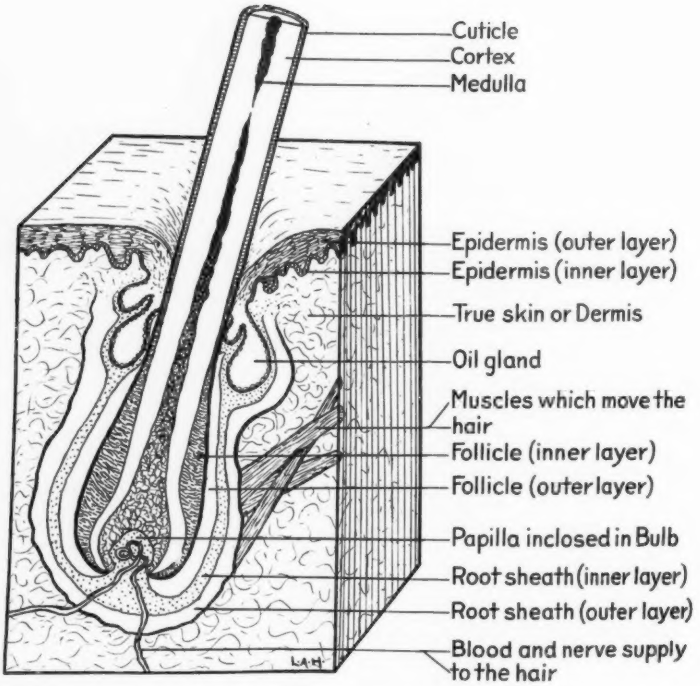
A microscope with the usual series of lenses in the upright tube, and an extensible eyepiece at C, above a small "stage" (B) on which the hair to be examined is mounted (there is a round perforation at the center of the stage); a microscope lamp (A), condensing lens under the stage (D), a round adjustable double mirror at the base of the microscope (E), an additional tungsten lamp (F), and an additional condensing lens movable on a separate stand (G).

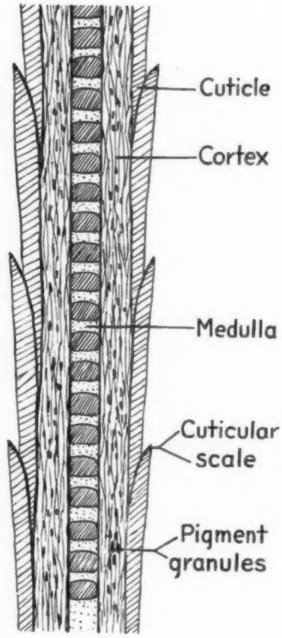
For the satisfactory examination of mammal hairs under the microscope two types of illumination are required.

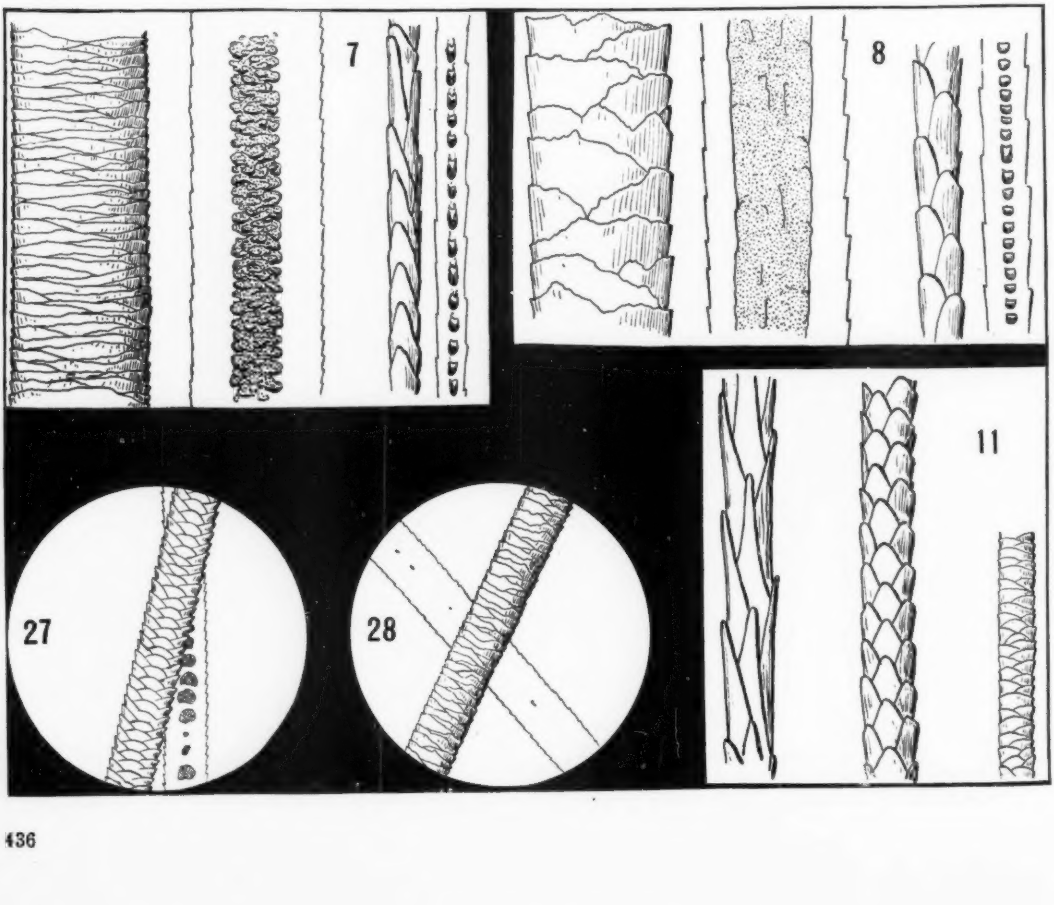
At the left is shown the arrangement of the apparatus for examination of the hair with direct light on a dark field (the hole in the stage is covered with a piece of black velvet). The light is directed from *A* through the condenser *G* to the object at *B* (and viewed, of course, through the eyepiece)

In the middle the equipment is arranged for examination of the hair by transmitted light; that is, light from *A* is thrown on the mirror *E*, which reflects it upward through the substage condenser *D*, and by way of the opening in the stage through the object at *B*. Transmitted light shows the hair in optical section and is accordingly useful for studying the medulla. A camera lucida (*H*) allows an exact tracing of the object to be made

At the right the arrangement of apparatus allows examination by both direct and transmitted light; (1)—Light from *F* passes through the condensing lens *G* and is focused directly upon the object at *B*. (2)—Light from *A* passes through the object at *B* by way of the mirror *E*, the substage condenser *D*, and the opening in the stage. Photomicrographs may readily be taken with each of these types of illumination, accentuating different features as shown on page 444


Cuticle
Cortex
Medulla
Epidermis (outer layer)
Epidermis (inner layer)
True skin or Dermis
Oil gland
Muscles which move the hair
Follicle (inner layer)
Follicle (outer layer)
Papilla inclosed in Bulb
Root sheath (inner layer)
Root sheath (outer layer)
Blood and nerve supply to the hair


Cuticle
Cortex
Medulla
Cuticular scale
Pigment granules


7
8
11
27
28

cortex of minute particles of some pigment. These particles are arranged in the different hairs in fairly definite and characteristic patterns, and may often serve as aids in identification.

(4) The *cuticle*, or outermost integument of the hair shaft. This is composed of thin, transparent, and colorless scales of varying forms and dimensions, arranged in series, sometimes overlapping like the shingles on a roof or the scales on a fish.

Fur Hair and Protective Hair

Most mammals possess at least two kinds of hair—a short, thick, fine coat next the skin, which is termed the fur hair or the under hair, and a longer, coarser, usually stiffer hair, which overlies the first, and to which has been given the name protective hair, or over hair. It is the first-named hair, the fur hair, which usually forms the greater part of the body covering (see 27 to 88, pages 436–443, in each of which two shafts are shown, the one treated to show the medulla, the other to show the cuticular scales). In the fur hair and protective hair from the same animal the cuticular scales and medullas differ (for example see hair of the European beaver and of the skunk, Nos. 7 and 8, on opposite page), and these characters can therefore be used to distinguish the two kinds of hair when only small fragments are to be had, or when the hairs have been clipped or dyed, as they frequently are when made up into furs. Some animals, like the duckbill or platypus and the spiny anteater, possess a great many different modifications of these two kinds of hair, each one in most respects quite unlike the others.[1] This is rarely the case, however, among other mammals. Of each of these two main kinds of hair there are two varieties:

(1) Hair in which there is a simple medulla consisting of a relatively small shaft with a single central column or a rod of separate cells (see 85 and 69, page 443).

(2) Hair in which there is a compound medulla consisting of a somewhat larger shaft with two, three, or even four longitudinal, parallel columns of small, separate medullary cells (see 80 and 81, page 443), showing hairs of the pocket rat and the Cape jumping hare). Hair with compound medulla is comparatively rare.

A glance at the numerous figures of magnified hair shafts presented with this article[2] shows the existing wide variety in form of the medullas and cuticular scales. These figures indicate the nature of the scales and medullas as they appear one third the distance from the base to the tip of the hair shaft. Here it is that, ordinarily, the medulla reaches its greatest expansion, and the cuticular scales show their forms most fully developed. Farther along in the direc-

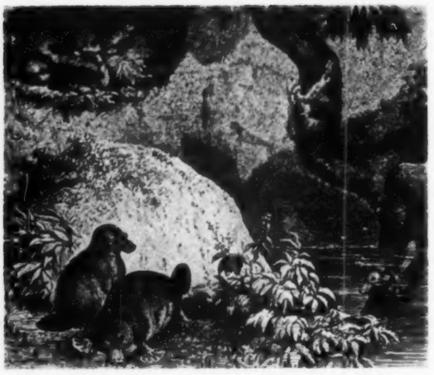
[1] Hausman, L. A., "A Micrological Investigation of the Hair Structure of the Monotremata," *American Journal of Anatomy*, September, 1920.

[2] For the use of these figures, as well as of several others in this paper, the author is indebted to the *Am. Naturalist*, which has kindly allowed their reproduction from his paper, "Structural Characteristics of the Hairs of Mammals."

Description of upper figures on opposite page.—The microscopic anatomy of mammalian hair presents features that are constant for different species and groups. The hair forms accordingly permit of systematic classification and make possible the identification of any given specimen as that of a certain animal, a fact which is of obvious practical importance in the detection of substitutes for commercial furs. These two drawings depict the generalized microscopical structure of a hair in its follicle (at the left) and of the hair shaft (at the right, greatly magnified). After a hair is started, the new growth occurs only at the bulb in its root where there is connection with a blood and nerve supply.

Description of lower figures on opposite page.—The form of the scales varies somewhat in different regions of the hair shaft probably because of increasing wear toward the tip. This is well shown in the illustration of the hair of the duckbill (11), the sections taken from near the skin (at the left), midway to the tip (middle), and near the tip.

Most animals possess a short thick coat of fine fur hair next the skin and an overlying coat of coarser "protective hair." These two types are figured for the European beaver (7) and the skunk (8). The two large hairs on the left in each instance are the protective hairs, treated to show the cuticular scales and the medulla, respectively; on the right are two fur hairs similarly treated. Figure 27 shows the unusual regularity in geometrical design of the scales on the fur hair of the black lemur. The hair drawn in Fig. 28 was taken from the remains of a mammoth (*Elephas primigenius*) found in Alaska.



The platypus or duckbill of Australia (*Ornithorhynchus anatinus*) is a creature which is partly aquatic, partly subaërial, and partly subterranean. It is furnished with many different varieties of hair; namely, fine long hair on the chin; the finest hair of the body about the ear; posterior to these, short, stiff hair, rather flattened; long, stiff, flattened hair on the under portion of the body; very stiff, almost bristle-like hair on the wrists; and long, soft, dark brown hair on the back. Besides all these different sorts of hair, the platypus also possesses still another type, the fur hair, underneath the long brown hair of the back. (Drawing from Kingsley's *Natural History*)

tion of the free extremity of the shaft the medulla usually becomes reduced, broken up into fragments, or pinched out altogether. The cuticular scales, likewise, undergo a progressive alteration of form as the tip of the hair is approached, owing probably to the increasing amount of wear upon their free edges. This is remarkably well illustrated in the hair of the platypus, in which the scales may be very long and pointed at the base of the hair, reduced to an oval form midway in the hair's length, and to flat, even-margined scales toward the tip (see 11 in illustration on page 436).

All of the fur, or all of the protective hair, even, of any given individual animal is not of exactly the same diameter: hair varies in this regard considerably, differing in the range of variation among different species of mammals, and a somewhat less range of variation occurs in the averages of the diameters of the hairs of different individuals of the same species. Hence, too much importance cannot be attached to hair magnitudes, except, possibly, when dealt with in large averages, and between large groups, for example, families or genera. Inasmuch as the hair shafts figured here vary in diameter from 6.80 microns to 160.00 microns,[1] to show them to the same scale, and at the same time to make the smaller hairs of sufficient size to represent clearly the cuticular scales and medulla, was obviously impracticable. The arbitrary expedient was therefore adopted of representing all the hairs whose diameters were equal to, or less than, the average diameter of the human head-hair (roughly 51.00 microns) as one standard size; and of representing all those hairs whose diameters were greater than that of the human hair as of another standard size. The latter hairs are represented as being only slightly larger than the former. In order that an appreciation might be had, however, of both the relative and actual magnitudes of the hairs in the figures, the average diameter of the fur hair of each species is given in microns after the name.

Mammal Hairs Identified and Classified by Means of the Cuticular Scales[2]

A comparison of the various cuticular scales exhibited by mammalian hairs shows that they may readily be assigned to two great groups:

(1) Imbricate—Those that lie singly, overlapping about the hair shaft, and

(2) Coronal—Those that encircle the shaft as a continuous band with a resemblance in some instances to the shape of a coronet.

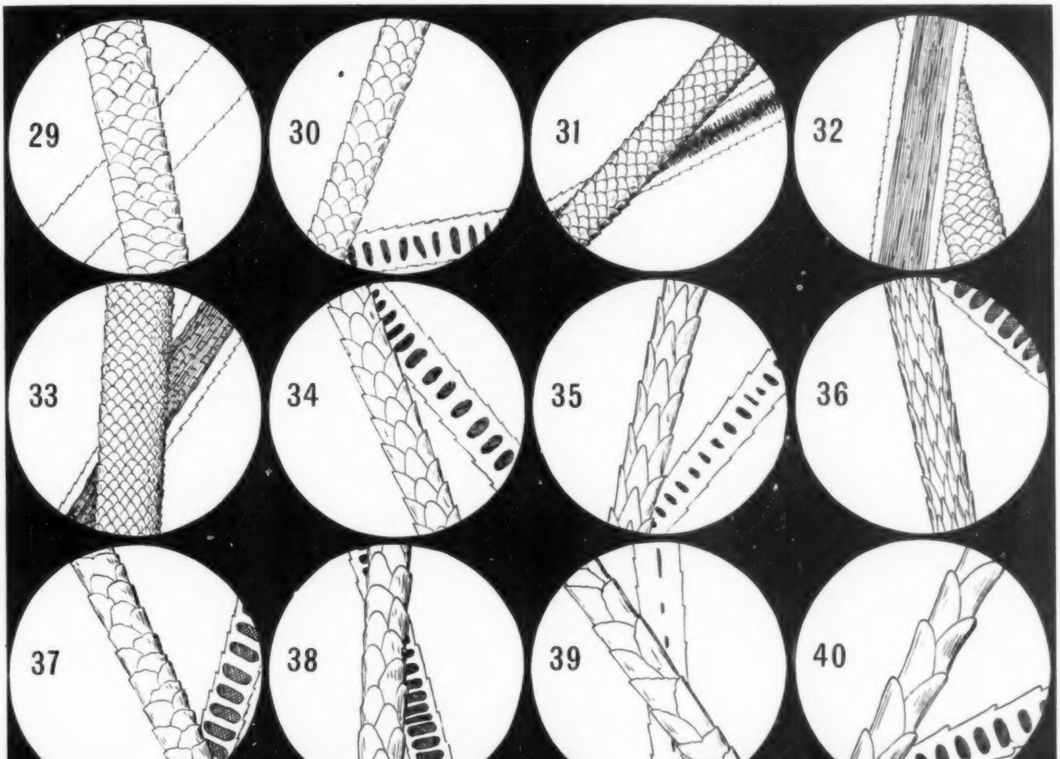
The simplest form of the imbricate scale is the ovate type, shown in the hair of the yellow-haired porcupine (29). In four other examples of this type, including the pronghorn and True's white-tailed deer, the scales undergo a diminution in size and an increase

[1] One micron is 1/1000 of a millimeter, or about 1/25,400 of an inch.

[2] Classification of forms of cuticular scales of the mammalian hair (see pages 439 and 440):

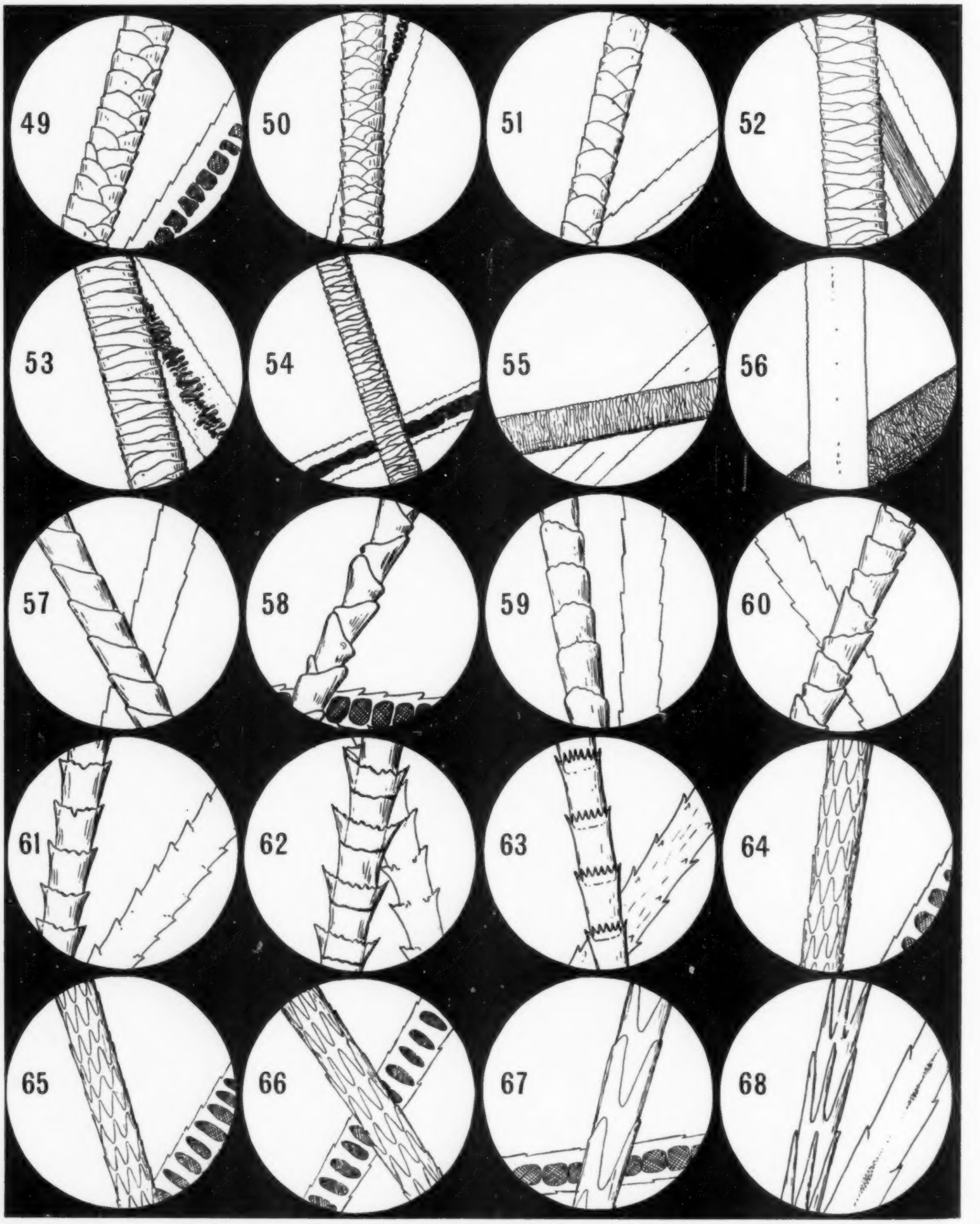
I. Imbricate
  1. Ovate—Five varieties, 29 to 33
  2. Acuminate—Three varieties, 34 to 36
  3. Elongate—Five varieties, 37 to 41
  4. Crenate—Seven varieties, 42 to 48
  5. Flattened—Eight varieties, 49 to 56

II. Coronal
  1. Simple—Two varieties, 57 and 58
  2. Serrate—Five varieties, 59 to 63
  3. Dentate—Five varieties, 64 to 68



The series of highly magnified hair shafts presented here and on pages 440 and 443 have been selected to exhibit different arrangements of the cuticular scales and medulla. (The measurements below are expressed in microns)

(29) x134 Yellow-haired porcupine (*Erethizon spixanthus*) 59.50
(30) x294 European mole (*Talpa europæa*) 17.00
(31) x167 Tibetan sun bear (*Helarctos thibetianus*) 30.60
(32) x79 True's white-tailed deer (*Odocoileus truei*) 102.00
(33) x79 American pronghorn (*Antilocapra americana*) 102.00
(34) x167 Pocket gopher (*Geomys tuza*) 29.10
(35) x186 Rabbit bandicoot (*Peragale lagotis*) 27.20
(36) x417 Baird's shrew (*Sorex bairdi*) 12.00
(37) x334 Lowe's tree shrew (*Ptilocercus lowii continentis*) 15.00
(38) x218 Tree shrew (*Dendrogale frenata*) 32.00
(39) x186 Three-toed sloth (*Bradypus tridactylus*) 27.20
(40) x357 Giant golden mole (*Chrysochloris trevelyani*) 14.00
(41) x385 Golden mole (*Chrysochloris leucorhina*) 12.50
(42) x250 Tana (*Tana chrysura*) 20.00
(43) x167 Patas monkey (*Cercopithecus patas*) 31.00
(44) x113 Titi (*Callithrix jacchus*) 80.00
(45) x60 Tenrec (*Centetes ecaudatus*) 100.00
(46) x104 Peba armadillo (*Tatu novemcincta*) 76.50
(47) x79 Percheron mare 101.00
(48) x37 Dalmann's pangolin (*Pangolin dalmanni*) 220.00



The scales on the hair of the lion (52) are typical of the scutellation on large coarse hairs while the compact scales of the naked mole mouse (56) are characteristic of spines and bristles and the hair of animals sparsely covered. In the case of bats the scales show exceptional beauty under the microscope. The dentate forms appear most frequently among the carnivores and rodents. (The measurements below are expressed in microns)

(49) x156 Restless cavy (*Cavia porcellus*) 45.00
(50) x167 Sagouin (*Hapale penicillata*) 30.00
(51) x192 Opossum (*Didelphys marsupialis caucae*) 25.50
(52) x108 Lion (*Felis leo nyanzae*) 74.00
(53) x59 Northern sea lion (*Eumentopias stelleri*) 153.00
(54) x267 Spectral tarsier (*Tarsius tarsius*) 15.00
(55) x98 Apar (*Tolypeutes conurus*) 51.00
(56) x104 Naked mole mouse (*Heterocephalus glaber*) 77.00
(57) x556 Red bat (*Lasiurus borealis*) 8.50
(58) x278 Malay vampire bat (*Megaderma trifolium*) 18.00
(59) x455 Musky bat (*Noctilio leporinus*) 11.00
(60) x500 Phyllops (*Phyllops falcatus*) 10.00
(61) x556 Mastiff bat (*Molossus sinaloae*) 9.00
(62) x556 Wrinkled-lipped bat (*Nyctinomus bocagei*) 8.50
(63) x714 Intermediate bat (*Mormops intermedia*) 6.80
(64) x314 Chinchilla (*Chinchilla lanigera*) 16.00
(65) x357 Scale-tailed squirrel (*Anomalurus peli*) 13.60
(66) x353 California sewellel (*Aplodontia californica*) 17.00
(67) x455 Mink (*Mustela vison aestuarina*) 11.30
(68) x556 European otter (*Lutra vulgaris*) 8.50

in numbers (see 30 to 33, page 439). A second type of imbricate scale, in which the apex tends to become more pointed, is illustrated in the hair of the pocket gopher (34). And there are other modifications (35 and 36) of this acuminate type which are well defined and evidently characteristic in general of the moles and shrews (Insectivora). Of particular interest is the very appreciably acuminate form shown in the hair of the Baird's shrew (see 36).

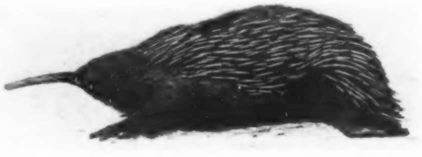
The elongate type of imbricate scale (37 to 41) is a rather uncommon form, particularly in its enlarged modification, as in the hair of the golden mole (41). The crenate type is very common, indeed it is believed that this is the predominant form of cuticular scale of mammal hairs. The hair of the tana (42) exhibits what we have called the simplest form of this type, a form which is to be distinguished from the ovate type of scale by the irregularity of the free edges of the scales. From this variety to the extreme form shown by the hair of the Dalmann's pangolin (48) there are a multitude of intermediate gradations. A very common form of the crenate type is that exhibited by the hair of the peba armadillo (46).

Second to the crenate sort of imbricate scale in frequency of occurrence, is the flattened type (49 to 56). The hair of the restless cavy (49) shows the form of scale which reveals its relationship to the simple ovate scale. The progressive flattening of the scales produces various intermediate modifications (50 to 56). The modifications represented by the hair of the lion (52) and by the hair of the Steller's sea lion (53) are those which we find usually associated with large coarse hairs, while stiff spinous hairs and spines nearly always exhibit a closely compacted modification of this form, similar to that shown by the hair of the naked mole mouse (56). It is interesting to note that, as in the case of the species just mentioned, wherever the hair of an animal is very sparse (whether it is spinous or not), there is usually encountered this type of closely compacted, flattened scale. The greater number of the species of the Primates (monkeys, apes, etc.) exhibit scales formed very much like those of the spectral tarsier (54).

The coronal scale (57 to 68) appears not to be subject to so many, or so diverse, modifications in form as does the imbricate scale. Three well-marked types can, nevertheless, be distinguished: (1) Simple, as in the hair of the red bat and Malay vampire bat (57 and 58); (2) Serrate, as in the hairs of the musky bat, *Phyllops*, mastiff bat, wrinkled-lipped bat, and intermediate bat (59 to 63); (3) Dentate, as in the hairs of the chinchilla, scale-tailed squirrel, sewellel, mink, and otter (64 to 68). The simple and serrate varieties are characteristic of the bats (Chiroptera), and their beauties under the microscope never fail to excite admiration.

The dentate coronal scale in its extreme form, as seen in the hair of the European or the American otter (68), is a scale of much beauty, rivaling the scales of some of the bats. The form of the coronal type most frequently encountered is that shown in the

This terrible panoply of spears borne by the spiny anteater (*Tachyglossus*) seems to indicate that its owner is one of the foremost advocates among mammals of aggressive militarism, yet such is not the case. The armament is purely for defense, and the creature confines its depredations to ant hills and colonies of other small insects. Nine different types of spines and spiny hairs are to be found upon the body



Another species of spiny anteater, *Zaglossus bruijnii bruijnii*, which possesses a greater amount of hair than the *Tachyglossus* and a smaller number of spines.—Note the abundance of fine hairs even between the spines on the sides of the body and the totally spineless area along the mid-dorsal line (photograph from Toldt)

hairs of the scale-tailed squirrel and the sewellel (65 and 66). This type occurs with great frequency among members of the flesh-eating (Carnivora or Feræ) and gnawing (Glires) groups of mammals.

Hairs of Mammals Identified and Classified According to the Medullas

The medullas of mammal hairs fall naturally into three types, not quite so sharply differentiated, however, as the types of cuticular scales. The groups are, nevertheless, well marked, and are as follows:

(1) Discontinuous, in which the medulla appears as a column of isolated cells of regular pattern and placement (as in 34).

(2) Continuous, in which the medulla is in the form of an apparently more or less solid rod (as in 32).

(3) Fragmental, which is a form of medulla (86) probably resulting from the gradual breaking down of the second or continuous type.

The medullas, like the cuticular scales, undergo an immense number of intricate variations[1] among the different species. A glance at the figures from 27 to 88 will afford some notion of the number and nature of these various formal modifications.[2]

The simple discontinuous ovate medulla (69 to 72) is the most common medulla encountered. The flattened medulla (76 to 79) seems to be the next in frequency of occurrence, and the elongate medulla (73 to 75) the last. Compound medullas, such as those shown in the hairs of the pocket rat and Cape jumping hare (80 and 81), are uncommon. Many of the rabbits (Leporidæ) exhibit such hairs. Two varieties of this type of hair can be differentiated on the basis of the shape of the individual medullary cells or chambers (80 and 81).

The continuous medulla either exhibits traces of its coalesced medullary cells along the column or is homogeneous. The first or nodose variety is shown in the hairs of the opossum, roe deer, and great anteater (82, 83, and 84), and the second in the hair of the reticulated giraffe (85). These two varieties, and more especially the latter, seem to be characteristic of the split-hoofed group of mammals (Bovidæ).

The fragmental medulla deserves mention quite by itself. It appears to be derived by the breakdown of the continuous homogeneous medulla (85), and all the gradational stages of such a suppositive breakdown can be found, extending from such a form as that shown by the hair of the Sumatran rhinoceros (86) through various other more reduced forms (87 and 88), to no medulla at all (see 57). Not infrequently irregular masses of displaced medullary cells are encountered in hairs otherwise exhibiting no appreciable medulla in the usual location in the shaft.

General Observations

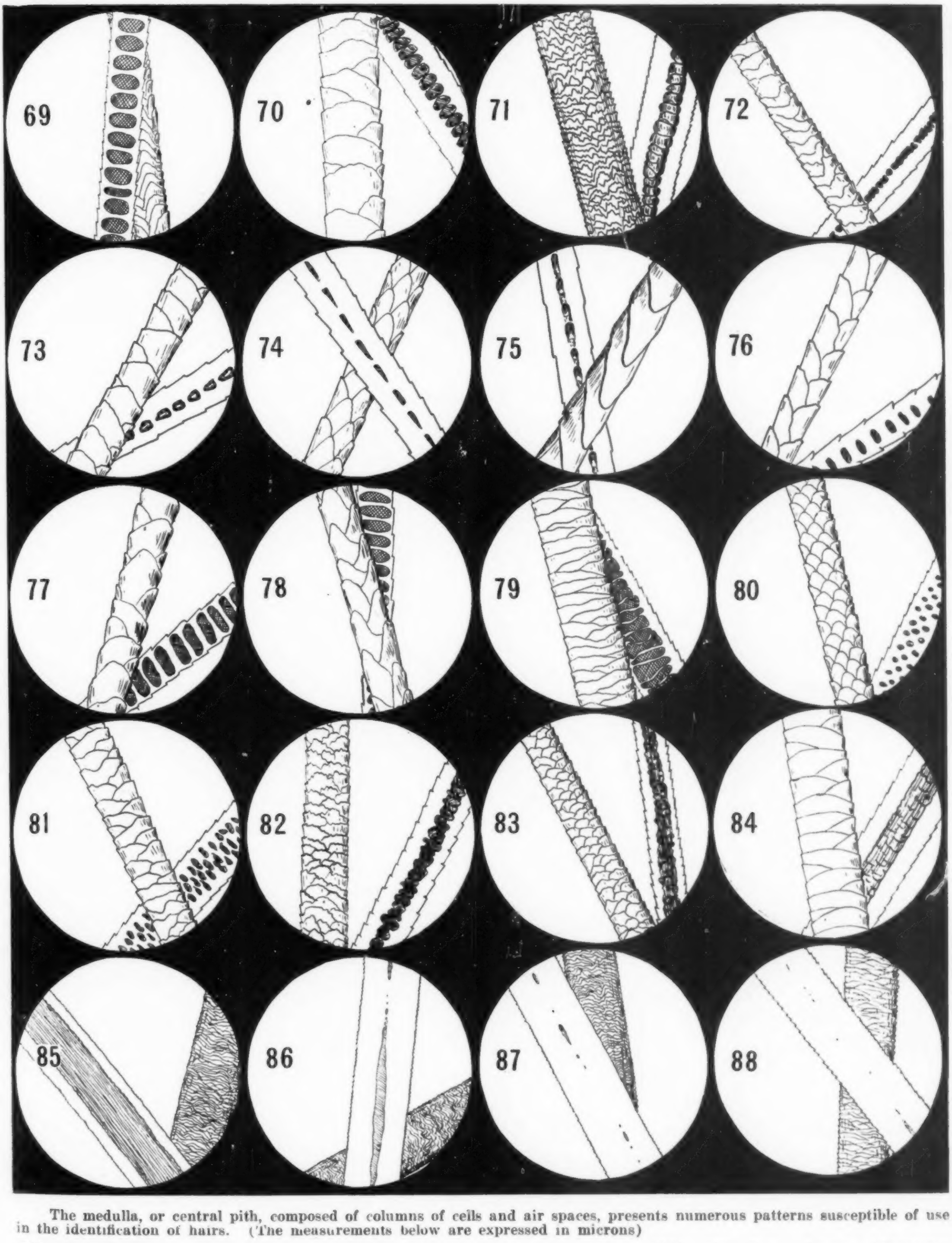
As a rule, those hairs of the least diameter exhibit, relatively, the largest cuticular scales, and conversely, those of the greatest diameter, the smallest scales. Again, in the case of the very largest and most rigid of hairlike structures, the spines, such as those, for example, borne by the spiny anteaters (see page 441), the free outer edges of the scales (at least upon the distal three fourths of the shaft) are usually worn down to such a degree that the outlines of the individual scale edges are no longer visible, and the surface of the spine presents a smooth, glossy, polished appearance. Where such conditions occur, scales more or less unmodified by attrition are usually discoverable at the base of the spine, just above, or beneath, the mouth of the follicle.

The fact that the free outer edges of the

[1] Classification of the forms of medullas of mammalian hair (see page opposite):

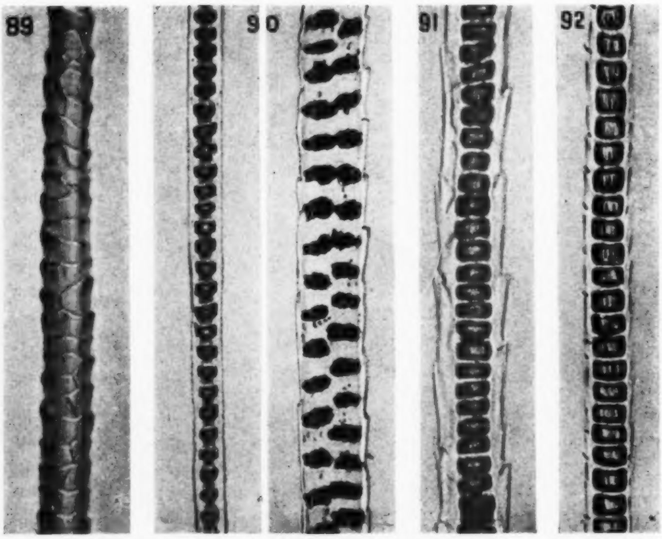
- I. Discontinuous
  - A. Simple
    - 1. Ovate—Four varieties, 69 to 72
    - 2. Elongate—Three varieties, 73 to 75
    - 3. Flattened—Four varieties, 76 to 79
  - B. Compound
    - 1. Ovate—80
    - 2. Flattened—81
- II. Continuous
  - 1. Nodose—Three varieties, 82 to 84
  - 2. Homogeneous—85
- III. Fragmental—Three varieties, 86 to 88

[2] However much two hairs from two different species of mammals may look alike, a comparison of the scales, medulla, pigment granules, relative and actual dimensions, and interrelationships of these elements will not fail to reveal constant and appreciable differences.



The medulla, or central pith, composed of columns of cells and air spaces, presents numerous patterns susceptible of use in the identification of hairs. (The measurements below are expressed in microns)

(69) x263 Gundi (*Ctenodactyles massoni*) 19.00
(70) x120 Cuon (*Cuon alpinus*) 75.00
(71) x114 Hedgehog (*Erinaceus hindei*) 98.75
(72) x294 Woodchuck (*Arctomys Monax*) 17.00
(73) x231 Short-nosed bandicoot (*Parameles obesula*) 25.50
(74) x250 Racoon (*Procyon lotor*) 20.40
(75) x546 European beaver (*Castor fiber*) 11.30
(76) x294 Deer mouse (*Peromyscus leucopus*) 17.00
(77) x217 Lerot (*Eliomys nagtglassi*) 23.00
(78) x313 Strand mole rat (*Bathyergus maritimus*) 15.50
(79) x52 California sea lion (*Zalophus californianus*) 153.50
(80) x192 Pocket rat (*Thomomys nevadensis*) 25.50
(81) x222 Cape jumping hare (*Pedetes caffer*) 27.20
(82) x171 Opossum (*Didelphys virginiana*) 40.80
(83) x50 Roe deer (*Capreolus capreolus*) 100.00
(84) x59 Great anteater (*Myrmecophaga tridactyla*) 136.00
(85) x160 Reticulated giraffe (*Giraffa reticulata*) 50.00
(86) x53 Sumatran rhinoceros (*Ceratotherium sumatrensis*) 152.00
(87) x50 Hippopotamus (*Hippopotamus amphibius kiboko*) 160.00
(88) x114 Borneo porcupine (*Triohys lipura*) 70.00



Photomicrographs of mammal hairs.—(89) Wool from the American Shropshire sheep, showing the imbricate cuticular scales. This hair was photographed by a combination of reflected and transmitted light (see figure at the right on page 435); mounted in air only.

(90) Fur hair from the back of the common house mouse (*Mus musculus*), viewed by transmitted light (see middle figure on page 435); hairs mounted in oil of amber. The hair at the left has a simple medulla; that at the right, a compound medulla. Note the enlarged character of the medullary cells of the latter and their irregular outline.

(91) Fur hair from the civet cat (*Arctogalidia fusca*), mounted in oil of amber and viewed by transmitted light.

(92) Fur hair from the gray rabbit (*Lepus nutalli mallurus*), mounted in oil of amber and viewed by transmitted light

cuticular scales of hairs develop in such a way that they are directed away from the skin suggests that they may afford protection against the intrusion between the hairs —and so on to the skin itself—of foreign bodies, of parasites, and water. Furthermore, any such extraneous substances which may have gained entrance would tend to be worked outward away from the skin to the outer surface of the hair covering, by the motions into which the hair is thrown by the muscles of the body.

The technique of microscopical examination of hairs demands, primarily, an ability to manipulate the microscope and the source of the illumination of the object on the stage. Various arrangements of the microscope and microscope lamp secure different types (see page 435) of illumination, in order to bring into visibility the various structural parts of the hair (89, 90, 91, and 92 on this page). Photomicrography gives earnest of becoming a valuable aid in the study, not only of the cuticular scales or medullas, but more especially of the pigment granules—their shape, color depth, and patterns of arrangement.

A study of the structures and identification characteristics of animal hairs, formerly of interest merely because of its zoölogical significance, is rapidly becoming applicable in industrial fields as well, and particularly at present in the field of the fur trade, for it is now possible so to clip, dye, pull, and otherwise alter furs of certain types that their original appearance is entirely lost, and they may be sold under names not their own. Inferior furs, remodeled, may be sold under the names of furs much superior in wearing quality, or in warmth, or in both; as, for example, when remodeled, rabbit (a fur notably poor in wearing quality) is sold as ermine, or remodeled muskrat as seal! Such remodeled furs may often be sold at ten times their legitimate value, warmth and durability considered! The pelts of animals from warmer latitudes, such as the opossum, woodchuck (marmot), raccoon, and certain species of monkeys, are worked up by skilful dressers into products very different from their originals. The names which are given to such remodeled furs are the names of animals of colder latitudes, such as otter, seal, sable, etc., animals which possess furs superior to those of the creatures of warmer zones in respect to denseness and softness of the under or fur hair, and to fullness and length of the over or protective hair. Furthermore, the dyeing and processing to which the warmer latitude furs are subjected render the hair less durable because more brittle. It is clear that there exists a need for some definite criterion by means of which furs, no matter how altered by the dyer and remodeler, can be indubitably identified as to species source. This need the microscopic study of the hair shafts of mammals will help to meet.

Professor Henry E. Crampton, of Columbia University and the American Museum of Natural History, has led a series of expeditions to the islands of Polynesia for the study of zoögeography and evolution

Research in the South Seas

With editorial introduction and a review of a recent study on the land snails of Tahiti [1]

EVER since Darwin put forward the theory of Natural Selection as an explanation of the way evolution works, scientists everywhere have been weighing it in the balance and searching for a more fully satisfactory explanation. It is recognized that the survival of the fittest according to a selection by nature from among the variable members of a race is surely not the whole, in fact, must be but a small part of the story of the cause of evolution and its method of procedure.

Thus today whether the aim of a man's research work purports to be morphological, embryological, cytological, physiological, zoögeographical, or taxonomic, quite certainly the investigator himself has one main hope. He desires to discover evidence along contested evolution problems: whether in any given group of animals or plants evolution works equally and at random in very many different directions, or along a few definite lines only; whether new species are built up slowly from accumulated small variations, or come into existence by leaps—by mutation, as sports; whether evolution is a force ploughing its way in the given group to a definite end in accordance with chemical and physical law and from internal urging, or, if evolution is effected by such a growth force, whether the direction taken by it be controlled by the environment. There are, suffice it to say, various schools of belief among scientists today.

An intensive work of investigation by Professor Henry E. Crampton, of Columbia University and the American Museum of Natural History, on the land snails of Tahiti in the

[1] *Studies on the Variation, Distribution, and Evolution of the Genus Partula. The Species Inhabiting Tahiti.* By Henry Edward Crampton. 313 pp., 34 plates, 252 tables, 7 text figures. Publication No. 228 of the Carnegie Institution of Washington, January, 1917.

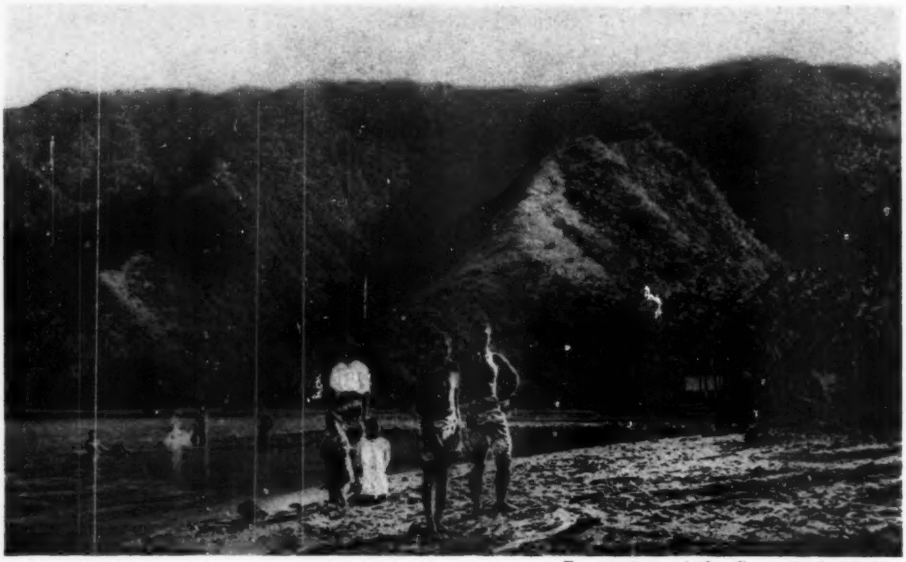
By courtesy of the Carnegie Institution

View of Taiarapu, the smaller, lower part of Tahiti Island. The islands of Polynesia, resulting from a subsidence of the land, are the tops of mountain ranges, volcanic masses with great radiating systems of contiguous valleys

South Seas, is of particular interest, in part because of the unique opportunity for a study of evolution given by these numerous sharply marked-off island species, but primarily because of his conclusion after many years' study of the data that, although each group of islands has its own group of species, each island its own species different from all others, and even in many cases each of the radiating valleys of each island its form peculiar to it, these have not been evolved in any degree by the influence of the environment. We quote him in the matter:[1] "In a word, the rôle of the environment is to set the limits to the habitable areas or to bring about the elimination of individuals whose qualities are otherwise determined—that is, by congenital factors."

Professor Crampton had long been conducting experimental studies in variation and selection on the saturnid moths. As a check to that work, which necessarily was carried on under the artificial conditions of the lab-

[1] "Résumé," p. 311.



By courtesy of the Carnegie Institution

Looking into three valleys on the southern side of Tahiti.—The high temperature, large amount of moisture, and low barometer make the many valleys of Tahiti ideal habitats for snails. Each valley may have its form peculiar to it. The tops of the ridges are dry and barren and the snails do not cross from valley to valley

oratory, he inaugurated this parallel study on snails under natural environmental conditions. On four of several expeditions made to Polynesia he has reported in a volume brought out by the Carnegie Institution, under the auspices of which three of the four expeditions were made (1907–8–9). The field survey has been exhaustive in Tahiti of the Society Islands, building on the former researches of Professor Alfred G. Mayor,[1] director of the department of marine biology, Carnegie Institution, Washington, and has also been extended into various of the Cook, Tonga, Samoan, Fiji, and New Zealand islands.

As Professor Crampton points out, the snails of the genus *Partula* are a most fortunate biological group in which to study evolution—compared, for instance, with any continental group where there are not geographical barriers sharply marking off the species. In the case of *Partula* the area of its distribution is comparable in size with the United States, but it is made up of ocean waters with habitable islands (the tops of mountains after subsidence) acting as isolated centers of evolution.

In the work in Polynesia Professor Crampton collected about 80,000 snails from two hundred of the valleys in the Society Islands. Visitors to the American Museum will be interested in the topographical model of Tahiti, exhibited in the Darwin hall. Shells from the various valleys are suspended above the model in their respective places, presenting graphically a suggestive story of distribution in the south Pacific.

We bring the memoir on *Partula* to the attention of readers of NATURAL HISTORY in the following review[2] by Professor Mayor, of the Carnegie Institution:

The present volume deals with snails from Tahiti alone, and the thorough, scholarly, and conservative treatment given the subject renders this work of paramount value to all future students of the variations of *Partula*.

Not alone were variations and distribution of the adult snails studied, but the young contained in the brood pouches of the adults were dissected out, thus throwing light upon the fecundity of each variety and the ratio of elimination of the young before they can reach maturity.

Crampton shows that these snails are not found in the dry lowlands along the shore, nor do they occur in the cold regions of the high peaks of the interior, for a temperature of 55°–60° F. stops their activity. The snails are therefore restricted to the relatively moist deeply wooded troughs of the intermediate regions of the valleys, where they are commonly found during the daytime on the undersides of the leaves of the banana, wild plantain, caladium, turmeric, wild ginger, and dracæna.

The ridges between valleys are generally dry, and thus the snail population of each valley is more or less isolated. Crampton finds that these snails descend from the trees and bushes and feed during the night, or on moist days, upon decaying vegetation. The young and adolescent are more active in this feeding reaction than are the adults.

It has long been known from Garrett's studies[3] that the Tahitian species of *Partula* like the *Achatinella* of Oahu varied from valley to valley, some forms ranging over a wide area while others are restricted to a single valley, or even to a limited region within a valley.

In general, moreover, the farther apart two valleys the wider the diversity between their snails, although this is not always the case. Crampton's work has the merit of giving precision to our hitherto more or less vague knowledge of the distribution of the eight species of *Partula* found in Tahiti. He shows conclusively that great changes have occurred since Garrett studied the snails in 1861–84, and that in some cases the species have spread over wider areas and in the interval have produced some new subspecies or varieties. Thus the fascinating picture of a race in active process of evolution is presented. The details of this process are rendered clear by the excellent photographs of relief maps, and the numerous diagrams which accompany the text.

In a brief review such as the present it is not possible to do justice even to some of the more important details of Crampton's masterly work, but it is interesting to see that according to Garrett, *Partula clara* was rare and found only in a sector of valleys comprising about one fourth the area of Tahiti, while Crampton found it to be very common and to range over four fifths of the whole island, this dispersal having been accomplished by migration from the former restricted habitat of the species. There are now seven subspecies, and mutation has occurred not only in some of the new valleys the snail has occupied since Garrett's time but also in the area in which it was found by Garrett.

Partula nodosa, which in 1861 was confined to Punaruu Valley, has now migrated into six other valleys, and three new varieties have arisen in the area into which it has traveled.

[1] Mayer, A. G. "Some Species of Partula from Tahiti—A Study in Variation." *Memoirs Mus. Comp. Zool.*, Cambridge, Vol. XXVI, No. 2, 1902.

[2] By courtesy of *Science*, N. S., Vol. LI, No. 1310, February 6, 1920.

[3] Garrett, Andrew: "The Terrestrial Mollusca Inhabiting the Society Islands." *Journ. Acad. Nat. Sci.*, Philadelphia, Vol. IX, second series, part 1, 1884.

Nearly one half of Crampton's volume is devoted to an analysis of the group species *Partula otaheitana* with its eight subspecies and varieties of primary, secondary, and tertiary degree, thus constituting the most complex of the known species of *Partula.*

In Fautaua Valley these snails form an extremely complex colony which stands in parental relation to the diverse colonies of other valleys; for in any one of the latter the shells exhibit one combination or another of the so-called unit characters displayed by the Fautaua group as a whole. In this snail Crampton finds some evidence that in the variety *rubescens* red and yellow colorations bear a Mendelian relation to each other, red being dominant. On the other hand, in the variety *affinis* plain color seems to be dominant over the banded pattern in Mendelian inheritance.

Partula hyalina is peculiar in not being confined to Tahiti, for it is found also in Mangaia and Moki, of the Cook Group, and Rurutu and Tubuai of the Austral Islands, and in marked contrast to this wide dispersal *Partula filosa* is found only in Pirai Valley, and *P. producta* in Faarahi Valley and neither one has migrated from these valleys since Garrett's time.

Crampton concludes that in the production of new varieties the originative influence of environment seems to be little or nothing, and isolation is a mere condition and not a factor in the differentiation of new forms. This is in accord with the studies of Bartsch[1] upon *Cerion,* for he found that no new varieties were produced in any of the numerous colonies of Bahama cerions which he established upon the Florida Keys from Ragged Keys near Miami to Tortugas. When, however, these cerions of Bahaman ancestry crossed with the native from Florida, the second generation of the hybrids gave rise to a large number of variations both in form and color.

[1] "Experiments in the Breeding of Cerions." Vol. XIV, 1920. Papers from the Tortugas Laboratory, Dept. of Marine Biology of the Carnegie Institution of Washington.

This observation indicates that similar experiments should be conducted upon *Partula,* for it seems possible that new species may result from the breeding of mutations with the parent stock, or of species with species producing fertile hybrids unlike either of the parent stocks.

The editorial work on Crampton's volume reflects the greatest credit upon Mr. William Barnum, the well-known editor of all publications of the Carnegie Institution of Washington. The fifteen colored plates lithographed by Hoen are faithful reproductions of the colors and appearance of these snails, and the fact that the book is published upon the best of paper is fortunate, for it will be even more interesting to students a hundred years hence than it is at present.

Crampton's work is of such wide interest and importance, and in the light of Bartsch's observations, so suggestive of future experimental research, that it is hoped these studies may be pursued continuously under the auspices of the Carnegie Institution until final conclusions have been reached through breeding experiments conducted in the field. —ALFRED G. MAYOR, Director of the Department of Marine Biology, Carnegie Institution.

An exhibit in the Darwin hall of the American Museum.—Model of Tahiti, the largest island of the Society group in the south Pacific. Tahiti has an area of 350 square miles and consists of two parts, each with the crater of an extinct volcano. It reaches 7500 feet elevation, and is one of the "high" islands of the South Seas in distinction from the low coral atolls. The high peaks of Tahiti are hidden by clouds through the day. The model is a suggestive lesson in geographical distribution and evolution: it is constructed after charts, photographs, and observations by the expedition; shells of the snails inhabiting the various valleys are suspended above in their respective places

Fishes of the Spanish Main

By JOHN T. NICHOLS

Associate Curator of Ichthyology, American Museum of Natural History

PERHAPS nowhere in the world is there a greater variety of marine fish life than between Florida and the coast of Brazil. The trade-wind current westward along the coast of South America, entering the Caribbean and Gulf to emerge northeastward as the Gulf Stream, binds this whole area together, and gives it a remarkably uniform fish fauna, when one considers the distances involved. It follows that there are certain strategic localities, where if one were to look long and diligently enough there would be a chance of meeting with almost every kind of fish of importance of the entire area. Scarcely a student of American marine fishes since the time of Cuvier but has taken new plunder in the form of previously unknown species from the old Spanish Main. Years ago the statement that those waters had been "gone over with a fine-toothed comb" would not have sounded unreasonable, but in spite of the numerous species already known and described, new ones are continually turning up.

My first studies of West Indian fishes were made sixteen or seventeen years ago at a zoölogical laboratory which Professor Mark, of Harvard University, had just established in Bermuda. There still remain clearly in my memory many species as I saw them there—the schools of snappers skirting the shore, the big-eyed red squirrel fishes, the lizard fishes lying on the sand under the clear water in wait to dart upon their prey, and the long green houndfish (*Tylosurus*) swimming close to the surface and driving schools of "fry" (*Stolephorus*) into the air. How dazzling the white limestone roads with their tamarisks! It was midsummer, and low sprawling cedars gave no protection against the sun, more trying for a northerner than it had been at sea on the equator or in better shaded localities within the tropics. As a result, when at the end of our stay, Mr. Owen Bryant and I undertook a memorable cruise of a few days in an open dory we had lost our ordinarily excellent appetite for rough food. What, if anything, else in the way of provisions we had brought, I do not remember, but there was a large tea box full of dry toast. The day was hot. To be off and on the water was pleasant, skirting the shore at a fair distance, no land in view to seaward, but protected against ocean swell by reefs and shallows. The wind was light and baffling, the helmsman careless, and a sudden puff hove the dory's lee rail under and filled the boat one third with sea water,—and behold! the tea box with our store of food floated an instant, then gradually tilted, filled, and settled.

On the islet where we made camp by hauling the dory ashore, by great good fortune a Portuguese boy appeared who knew where milk was to be obtained; otherwise we should probably have gone hungry. This boy was also much interested in our marine investigations and on the morning we set sail again to end our brief cruise, he told us of a strange yellow fish in a fish trap off the shore of the islet, which investigation proved to be one of the surgeon fishes. These are species with an ordinarily sheathed, antrorse knife-like spine on the side of the tail, with which they very successfully keep their finny rivals at a proper distance. Gray and blue surgeons we knew of, but not a yellow one. The form of this individual was sufficiently different to assure us it was no mere color freak. This, the first unknown fish it had ever been my good fortune to meet, thereupon started for its final destination, the Agassiz Museum in Cambridge, and was later described as *Teuthis helioides* by Dr. Thomas Barbour. Occasional individuals have since turned up at Bermuda, but I have always felt a sense of proprietorship for this beautiful species, and am correspondingly pleased to find the American Museum's first specimen in a Bermuda collection recently received.

The same collection contains another old friend, the ocean pipefish (*Siphostoma pelagicum*), abundant in floating gulf weed fifteen hundred sea miles to the eastward of Bermuda. This slender little pipefish[1] seems not to invade, or at least very little, exactly similar gulf weed farther west which is occupied by the mouse fish (*Pterophryne*); in fact, aside from Bermuda, the

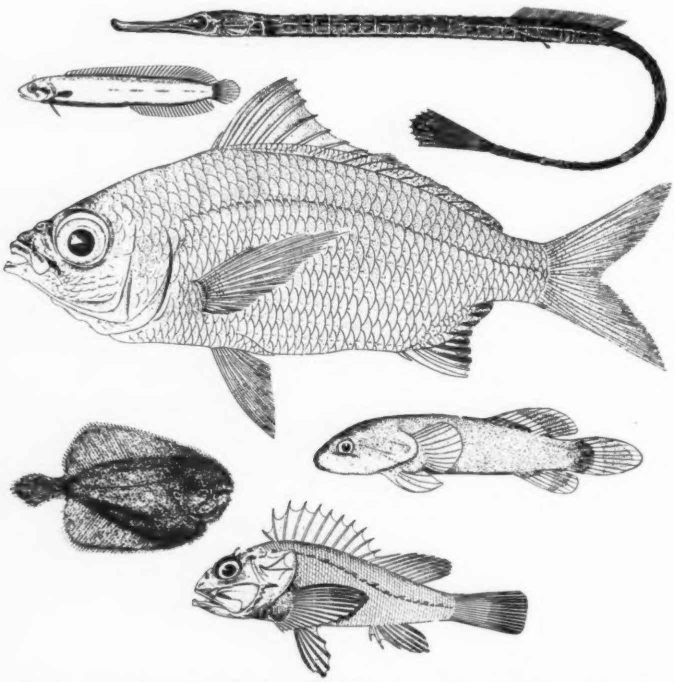
[1] Nichols, John T., 1910. A Note on *Siphostoma pelagicum* (Osbeck). *Bull. Amer. Mus. Nat. Hist.*, XXVIII, Art. 14, pp. 155–157.

species is not satisfactorily recorded from the West Indian region.

There is no better chance anywhere of learning the laws which govern the distribution of marine fishes than in this West Indian region. A proper study of the subject would be a creditable life work. During the last ten years the American Museum has built up a collection which will serve as a basis for such investigation when the man to undertake it arrives.

The New York Aquarium has always had a goodly representation of living West Indian fishes: active, changeable, brightly colored pomacentrids, wrasses, parrots, and angels of the reefs, elegant, free swimming snappers and grunts, larger groupers, evil-looking morays (the most degenerate of the shore eels), and many others. In earlier years these fishes of the New York Aquarium came almost entirely from Bermuda, more recently for the most part from Key West. By 1910 the American Museum had already acquired a fair series of such forms through the courtesy of the Aquarium, and in that year the writer spent five weeks as the Museum's representative, a guest of Messrs. Ernesto G. and Alessandro Fabbri, cruising among the Florida Keys. We were well fitted out with collecting equipment and devoted ourselves to obtaining as many as possible of the species of fishes there present, for the Museum's reference collections. In spite of the short time available, the work was so thoroughly successful that it has not since seemed necessary to make a point of acquiring further large general collections of fishes from the West Indian fauna.

Incidental to gathering and caring for this material, considerable knowledge was gained of the many species of fishes making up the complex of this fauna, and attention was first called to the innumerable interesting problems involved in their relationships and distribution. Since then each of several hasty trips south into the realm of warm blue water, sunny skies, and drifting sargassum, has opened wider vistas for research on such problems. More particularly were the problems comprehended during a month spent at Porto Rico in the summer of 1914, incident to the survey of the island by the New York Academy of Sciences. Each trip also has yielded discovery of valuable new species.



Some new fishes from the Spanish Main.—A few of the species collected for the first time, and described in the *Bulletin* of the American Museum of Natural History between 1910 and 1920. From top to bottom they are *Doryrhamphus sierra* (Porto Rico), *Stathmonotus tekla* (Florida), *Xystaema havana* (Cuba, Florida, Brazil, Porto Rico, Turks Islands), *Gobiesox yuma* (Florida), *Gymnachirus melas*, and *Scorpaena colesi* (both North Carolina)

On February 24, 1910, the Fabbri expedition secured a little blenny only 19 mm. in length, from a few inches of water on rocky shallows at Sand Key, off Key West Harbor, the second species, and it may be added the second individual also, of the genus *Stathmonotus* ever collected, the first having come from the same vicinity. Blennies may be divided into two groups, the one northern, subarctic, the other tropical. The strange thing

about *Stathmonotus* is that though clearly referable to the first group, it comes from waters occupied by the second. Does this mean that when the last nooks and corners of the Spanish Main have been investigated, we shall have representatives of every known type of marine fish, with the probable exception of those characteristic of the Antarctic and north temperate Pacific?

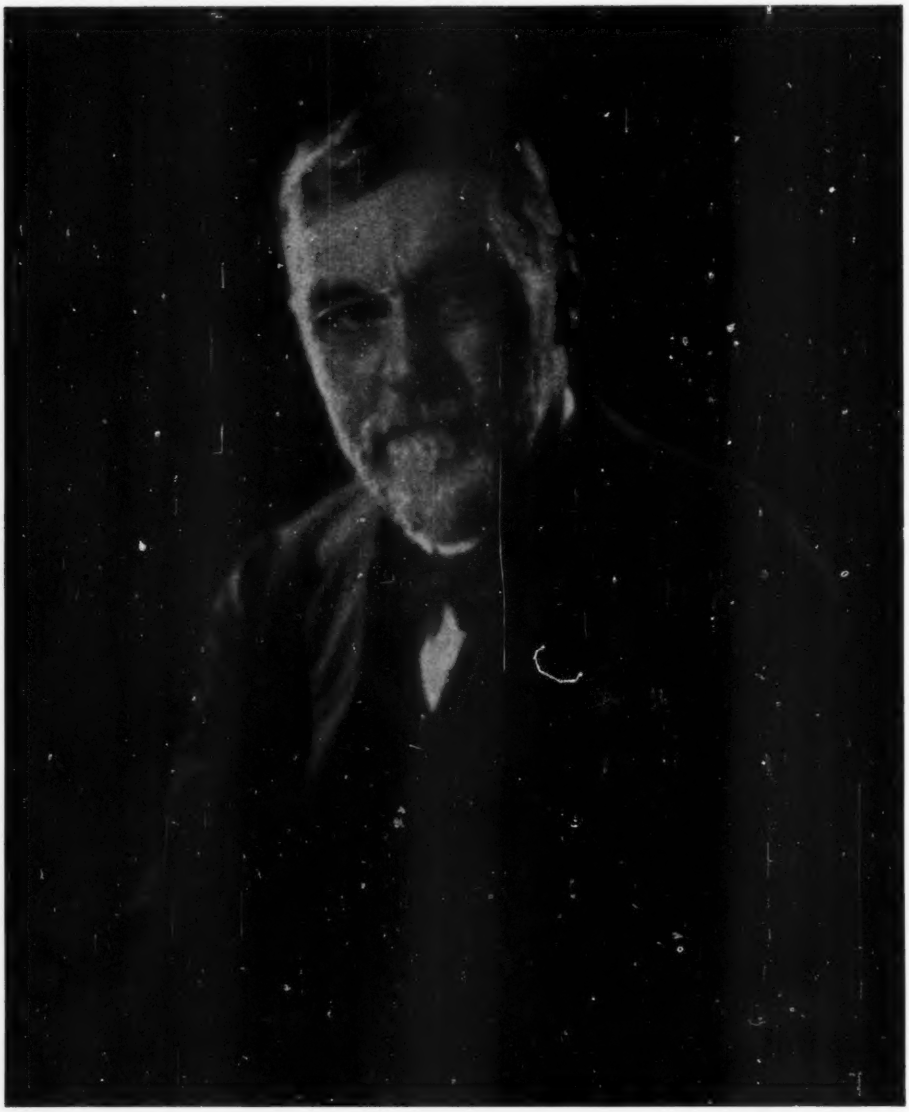
During a short stay in Cuba in 1912, considerable useful material was obtained in the fish markets, where a varying array of beautiful and interesting fishes is displayed each day. Desirous of "wetting a line" myself, for which there had been little opportunity, I went fishing one evening from a little pier on a sandy beach near Havana, and almost immediately caught a large-eyed silvery fish about six inches long, one of the mojarras. It resembled several closely related species with which I was familiar, more particularly, however, one from the Pacific, of which there were questionable records from the West Indies. More careful examination showed it to belong, really, to a different genus from any of these and a species as yet undescribed, the genus otherwise represented in our fauna by a single, different, unvarying form. It has been most interesting to have this new mojarra since turn up from Florida, Brazil, Porto Rico, and Turks Islands in the Bahamas, showing that it has a wide distribution and is not uncommon, and to speculate on the interesting questions raised as to relationships and evolutionary differentiation within the mojarras.

Among the shore fishes obtained at Porto Rico in 1914, two were described as new; and two other rather striking forms, a small filefish and an orange-yellow *Eupomacentrus* (one of the small gaudy fishes which dart in and out among the intricacies of rock or coral), proved a disappointment as both had been collected a few years before at Bermuda. The likeness of their species may be but coincidence, or the result of similar careful study, rather than wholesale collecting. Backed by other evidence, however, it seems rather to indicate an intimate relation between the fishes of the two islands. When the extent of this relation has been worked out, and determination has been made whether it be caused by comparative propinquity or some environmental similarity, we shall have an interesting sidelight on more general problems.

The northern limit of the West Indian fish fauna on our shores may be drawn rather sharply at the capes of the Carolinas. Recent studies made there over several consecutive summers by Dr. Russell J. Coles[1] in coöperation with the fish department of this museum, have turned up some extremely interesting fishes, thrown light on their habits and seasonal migrations, and demonstrated that the bight of Cape Lookout, North Carolina, is a veritable fish trap to catch wanderers from the South. The West Indian influence is felt considerably farther north along the coast, and a number of typically southern species occur among those known from within fifty miles of New York City, where they are most commonly met with in autumn. The latest addition to our recorded local list of fishes, No. 248 (to be exact) is of this sort. It is a cowfish, a small-mouthed, sluggish species, encased in a bony triangular shell, with hornlike spine over each eye, and was captured near Fire Island Inlet about November 1, 1919.

The Spanish Main is today a rich field for investigation. If a naturalist who sails its blue waters have knowledge of the common fishes sufficient to pick out at once an unusual one among them, whether it be darting into view for an instant below the clear water of the reef or lying on the slabs of some island fish market; if he have understanding of the varied habits and habitats of the different species sufficient to recognize, for instance, some peculiar bit of shore or reef as introducing unusual environmental factors; if again he have time and opportunity to follow the schools of young fishes which live under the drifting, highly-colored, bubble like, Portuguese man-of-war or about the sprays of gulf weed far out along the periphery of the Sargasso Sea, or to visit particular isolated islets or ledges where the fishes (to judge from the position on the chart) may furnish evidence for or against a hypothesis in mind—especially if he have alertness always to look out for and to seize stray bits of information drifting within reach, he could scarcely find cruising grounds in the world richer in scientific possibility.

[1] Of Danville, Virginia, author of various scientific papers on sharks and rays. Mr. Coles is the man who took the late Theodore Roosevelt out into the waters of the Gulf of Mexico and taught him the dangerous sport of devilfish hunting. See AMERICAN MUSEUM JOURNAL, Vol. XVI, April, 1916, pp. 217–27.

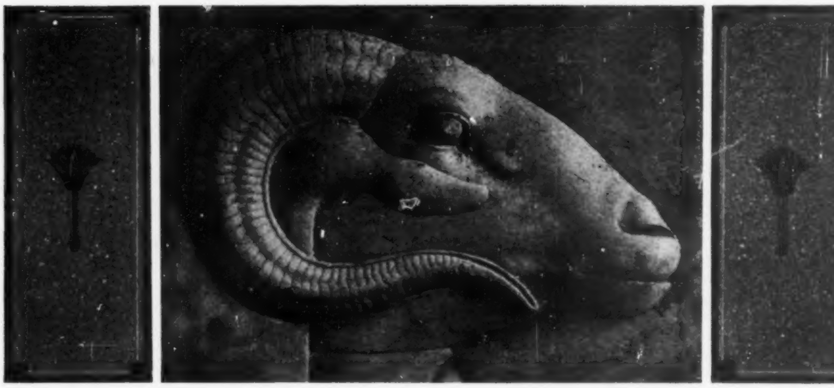


ROBERT W. DE FOREST

President of the Metropolitan Museum of Art, New York City, since 1913, formerly secretary (under the presidency of the late J. Pierpont Morgan, 1904–13). Mr. Henry W. Kent is the present secretary, acting with President de Forest

Men of influence and broad vision in New York City, interested in the fine arts not only as such but also from the human standpoint and believing that for all people beauty and refinement are better than the dreary or the squalid,—these men of the past fifty years and again of today have joined with the common people in giving our city the great Metropolitan Museum of Art at Eighty-second Street on Fifth Avenue. It is a partnership between private and civic ownership. Every taxpayer may take his family to it with pride, for he helps to support it every year; the man of great wealth may look upon it with what must be an immeasurable satisfaction, for by means of it he has brought relaxation and joy to a multitude of people.

Mr. de Forest was first actively connected with the museum in 1889, but his memory carries well back along the whole story of the institution's development, through association as a boy with his father-in-law, the first president, John Taylor Johnston



The Golden Jubilee of the Metropolitan Museum of Art, 1870-1920

WITH A PROPHECY OF THE PEOPLE'S MUSEUM OF THE IMMEDIATE FUTURE

"The diffusion of a knowledge of art in its highest forms of beauty will tend directly to humanize, to educate, and refine a practical and laborious people . . . also to show to students and artisans of every branch of industry what the past has accomplished for them to imitate and excel."

—Words of Joseph H. Choate at the dedication of the Metropolitan Museum of Art, in 1880.

NEW YORK CITY has two great museums which stand especially representative of the spirit of America. The Metropolitan Museum of Art is a treasure house of the truth and beauty that has been wrought by the hands of men, past and present,—according to the original words of its charter, a museum "to encourage and develop the study of the fine arts and the application of arts to manufactures and practical life." The American Museum of Natural History treasures and displays *natural* beauty and the truth of the earth and of created life as man finds it on the earth, and it also coöperates with manufactures and practical living.

Covering quite different fields, the two museums have nevertheless always been closely allied, primarily in that they exist freely for all people, and in that education is their chief purpose. Both institutions give without price not only of their accumulated beauty and knowledge, but also of the interest and time of their officials, to whoever asks, be his need or purpose what it may. The two institutions have developed side by side also in their methods of educational work, with lectures and instructors at the centrally located buildings and extension work in the form of loan collections to the city schools and libraries. Also they have traveled the same road in their coöperative and partnership relation with the state and city governments, so that in their buildings and maintenance they are truly the people's museums, public in the sense of ownership by all.

Likewise the two organizations trace their origin from very humble beginnings and pioneer effort of a group of public-spirited men—in some instances the same men for the two museums. As we view the institutions today, splendidly housed, with vastness of rich possessions, and national, even international, prestige and influence, it is not easy to realize that their beginning was humble, or if so that it was not in a very remote past. They have the development of mature institutions. Some of the European museums with which these American museums must be compared are several centuries old. Our American civilization as marked by free

The headpiece portrays a sculptor's model in limestone of a ram's head, Ptolemaic period, a recent gift to the museum and an interesting item of the Fiftieth Anniversary Exhibition.

institutions is about 300 years old. That only fifty years of this time has gone into the building up of New York's leading museums tells a story of astonishing growth.

The American Museum of Natural History, founded in 1869, passed its fiftieth anniversary in 1919, deferring a celebration until 1924.[1] The Metropolitan Museum of Art, inaugurated in 1870, reached its semicentennial one year later than the American Museum and has celebrated its Jubilee during the summer just past.

This celebration has been an auspicious occasion, setting off 1920 as a year memorable in the museum's history. For such have been the strides made by the New York art museum, especially during the period since the beginning of J. Pierpont Morgan's presidency[2] (1904–1913), that it stands today the leading art museum in America and even approaches a position as compeer of the greatest museums of the world.

The fiftieth anniversary celebration opened on May 7. On May 18 was the formal unveiling at the foot of the grand staircase in the Fifth Avenue hall[3] of two marble tablets bearing inscribed the names of the founders and benefactors of the museum. The addresses[4] of the occasion were delivered by representatives of the state and city, John H. Finley and Francis D. Gallatin, and by Elihu Root, of the trustees; also by three presidents of art museums, namely, Morris Gray, of the Museum of Fine Arts, Boston, Charles L. Hutchinson, of the Art Institute, Chicago, and Robert W. de Forest, for the home museum, New York.

One feature of the celebration, perhaps of greatest human interest, has been the room of the Memorabilia where hang portraits of the men who have stood back of the museum through the fifty years. No project prospers as has the Metropolitan Museum of Art, even when it has that greatest stimulus, the opportunity which a growing metropolis gives, without hard work on the part of its supporters and a steady holding fast to the ideal in view. We read in the faces that speak from the walls of this gallery the hopes and faith, and always the generosity of the man of imagination. They all live as we pass them in review, even those who do not walk the haunts of men today, for their work embodies the spirit of democratic America and connects inseparably the living future of the museum with its past.

The father of Theodore Roosevelt is there; John Taylor Johnston, man of affairs, was the first president; among the lawyers is Joseph H. Choate; among the business men, of course preëminently J. Pierpont Morgan, but also many others, especially of the present generation; among the literary men are William Cullen Bryant and George William Curtis; the artists constitute a long list. A vital fact, however, relative to the organization and after support of the Metropolitan Museum (as also of the American Museum), is that it stands for the interests of many classes, not of the artists alone, or of any other class predominantly, and the money of a large group of men, not of one or two only. The founders included the foremost literary, artistic, educational, and business interests of the time. That William Cullen Bryant, president of the Century Association, poet, journalist, art counselor, and publicist, gave the address at the initial meeting for the founding of the museum indicates the breadth of idea on which the institution rests.

The great human appeal of the Memorabilia carries our interest into a semicentennial pamphlet just published by the museum, "A Review of Fifty Years' Development." Although in statistical and catalogue form, it is not dry reading, and we quickly glean from it a story of growth according to what seems geometrical progression. The first gift was a Roman sarcophagus in 1870, the first purchase 174 paintings[5] in 1871. By 1875 the collections had reached proportions to have a first guide book printed. In 1886 was separated off from the general administra-

[1] Primarily because of conditions due to the war. Also with the hope that in the intervening five years the southern half of the museum building as planned and accepted for the city fifty years ago might then be completed and afford additional cause for the celebration of a golden jubilee.

[2] And therefore throughout the connection with the museum of the present president, Robert W. de Forest, who was secretary when Mr. Morgan was president.

[3] The decorations of the Fifth Avenue hall of the museum were designed for the occasion and carried out by Messrs. McKim, Mead, and White, Architects, of New York City, who gave their services in honor of the Jubilee.

[4] These addresses have appeared in the *Bulletin of the Metropolitan Museum of Art* during the summer months, 1920.

[5] These were bought without authority of the corporation and paid for with money borrowed for the purpose by one of the founders. During the present semicentennial exhibition, it has been observed that many paintings scattered through the various galleries were marked as belonging to this purchase of a half century ago.

tion a department of paintings, classical art was segregated in 1905, then Egyptian art, decorative arts in 1907, arms and armor in 1912, the Far Eastern arts followed, and the department of prints came into being in 1917.

The first bequest of money was in 1883. From 1886 on important bequests occur in close succession and increasing amounts; nearly twenty, about a fourth of them reaching or exceeding a million dollars. Most of these noteworthy bequests have come from New York, but the wide appeal of the institution is indicated, as called to the attention of the semicentennial gathering by President de Forest, in that the largest of all money bequests came from another state, and one other of more than a million came also from without the state.

Munificent gifts of art objects poured in to fill the continually increasing number of new additions to the building—the second addition in 1894, the fifth in 1910, the seventh in 1912, the eighth in 1917—until the building today, although still far from being complete, occupies a distance of four blocks along Fifth Avenue. The items of altruistic development especially shine out in the list of statistics: in 1891 the museum first opened its doors on Sundays; in 1907 was the first lending of lantern slides for the children of the city; 1917 saw the first manufacturers' exhibition in coöperation with the textile industries; 1918 the inauguration of free concerts. In other words, here is depicted the development of a storehouse of the beauty gathered by human thought and handicraft, and its continually growing use for the happiness and need of the dweller, permanent or transient, in New York City.

Since the formal opening, the celebration has taken the shape of special semicentennial exhibits, which more than 430,000 persons have visited in the six months between the opening in May and the closing November 1. So comprehensive has been this greatest exhibition of fine arts ever held in New York City that we have not space even to mention in general terms the main features or the chief loans. Fortunately, the shipments of Egyptian art, the first since the years of the war, arrived in time to form special attractions in that department. Also in the classical department various purchases made in Europe during the war were here in time to be exhibited.

The art collectors of New York City honored the museum as never before. More than one hundred allowed the most valuable works of art[1] from their homes and private galleries to come temporarily under the museum's care. These were installed alongside the permanent possessions of the institution in their proper places relative to period of art and department. Lovers of rare canvases, for instance, have had during the summer an enviable opportunity to study more than fourscore paintings from private collections representing periods from the thirteenth to the twentieth century.

Words of felicitation have been sent by the president and trustees of the American Museum of Natural History to the Metropolitan Museum of Art in recognition of the eminence it has attained. Earnest felicitations are extended by all its patrons and by all art and science museums of the country. But especially are tendered it the most profound respect and the warmest friendliness for its record in education,—for its effort to bring the history, biography, and beauty in its stores to the city's children, to workers in the industries, to the multitude who need to have knowledge of the part the fine arts can play in the leisure hours of life.

In the congested cities of this twentieth century social development has taken on an accelerated speed. Many questions regarding man's interests and behavior which had only moderate importance a half century ago now take on large significance. How the race shall spend its leisure is one of these: there arises a tendency to a new delimitation of human character when for the greater part of a crowded and mixed population the amount of leisure in each twenty-four hours and each seven days increases at leaps and bounds—accompanied by proportionately enlarged incomes to be used in this leisure. We can but wonder what direction the released and accelerated mental and spiritual powers will take. Always the question is, how large a proportion of the race in its instinctive reaching for knowledge and happiness will find something better than mere

[1] A complete list of the loans to the various departments is given in the *Bulletin of the Metropolitan Museum of Art*, May, pp. 112–19, June, pp. 144–45. 1920.

pleasure and the physical comforts of existence; and the responsibility for the answer to this question lies largely today at the doors of the country's public educational institutions.

If we look over our public sources of education and culture in America which aim to maintain active daily influence through a large part of the year, the museum, more than any other, perhaps, seems to be on the right road to fill the need; it can give pleasurable enlightenment along the lines of art and science in and for themselves and in relation to industry and the home. The combination of civic and private organization and control is particularly in the museum's favor.

The close observer would suggest one step the Metropolitan Museum of Art, the American Museum of Natural History, and all large museums of large cities should take at as early a date as practicable in face of difficulties of operation and finance. They should open their doors at night and advertise the fact largely. With enormous stores of latent energy why keep behind the ideal of accomplishment? Why keep behind the times, while other influences like the moving-picture theaters are developing a social power detrimental to refinement and culture which will be difficult to counteract? If there has been no "demand," that but urges the speedier action when the need is evident. The great mass of the people work by day. They have no opportunity to visit an institution that closes at five in the afternoon, whereas everyone seeks relaxation and entertainment in the glamor of the evening hours.

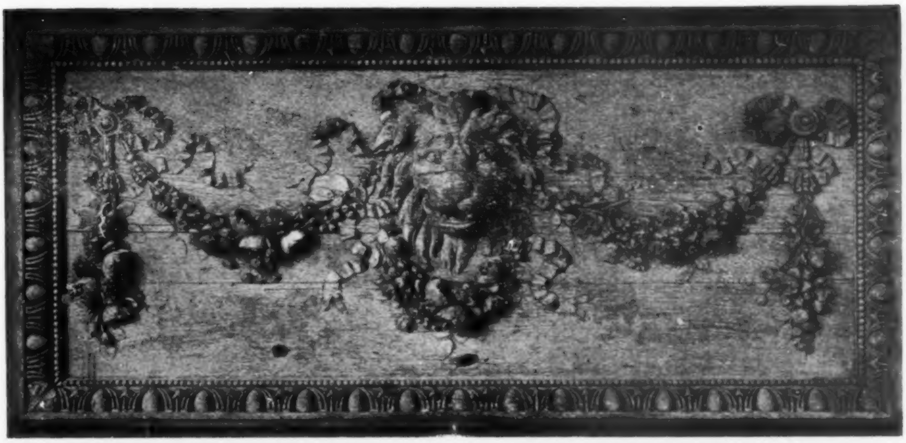
Our two great museums are so organized and conducted that they are adapted inherently to take a strong hold on the imagination and affections of the people and to become a cultural force of first magnitude. There is relatively little change necessary to increase a hundred-fold a usefulness already so great—except that each institution, as the years allow, will, possibly, incorporate the modern practical side of its work under the one roof, instead of merely coöperating with organizations of applied art and science, as at present.

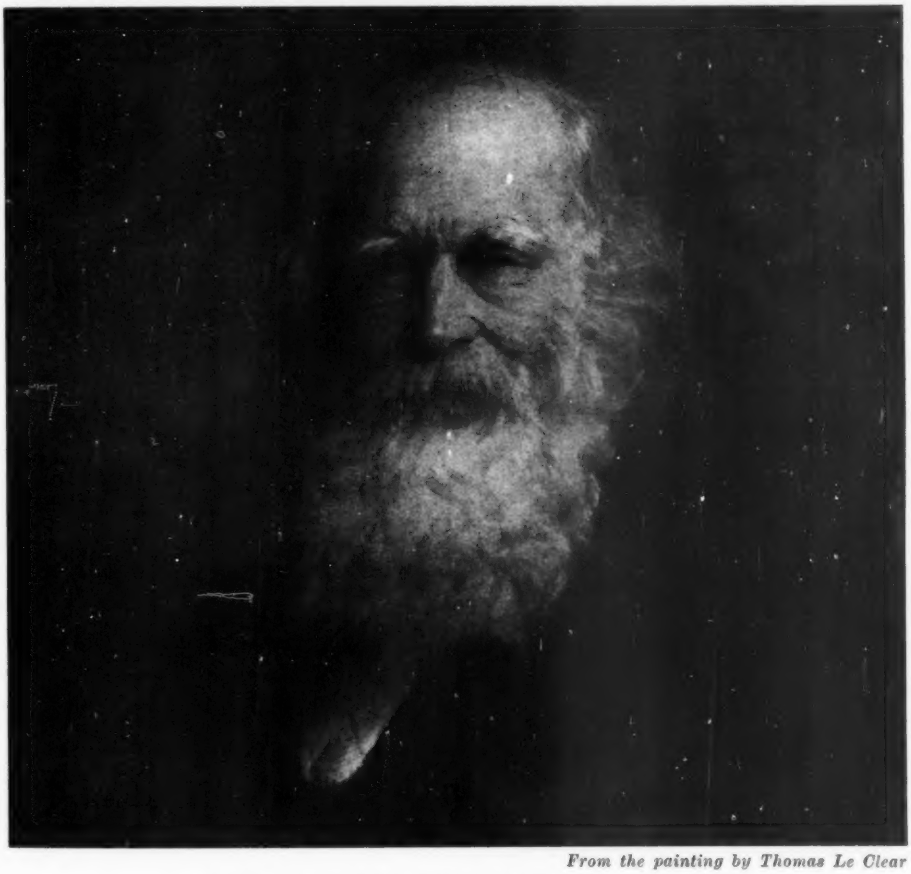
Among the immediate needs, then, in addition to night opening, are an increased staff of instructors in the exhibition halls, a larger number of popular lectures, and a larger number of motion pictures. Orchestral music also will probably soon take a considerable place in museum development—it has already been inaugurated for stated intervals in the Metropolitan Museum of Art. It will be one of the strongest of compelling invitations to thousands upon thousands of people when the time comes that it is installed a regular feature, a background of sound, dispelling formality and invigorating thought and conversation among the crowds who stand or wander at pleasure in the great lighted galleries of exhibits. We quote from President de Forest's semicentennial address in this matter: "What can make more for Americanism in its true sense, for good citizenship and neighborliness than our free concerts, the latest of which was attended by more than ten thousand people . . . great crowds from the east side, west side, and every side—men, women, and children—who are filled with rapture when music combines with its sister arts. . . ."

As to motion pictures in the museum, it may well be argued that their first place is in art and science, releasing in large part the field of dramatic action and portrayal of human character and passion to the greater dignity of the true theater. This refers to art and science in the broadest sense, covering the fine arts, with practical art in all its branches (industrial and decorative), realistic living nature on land and sea, expeditions and travel of every character for art or science, pure science, applied science in all its branches (hygiene, modern manufactures, inventions, etc., etc.), and especially a convergence of the fields of art and science in a study of man and of the highest mental accomplishments and ethical conduct of man.

The outlook thus over the combined fields of art and science is vast. Moreover, because of the very relation with man's activity and the advance of civilization these fields are daily widening their borders. To say that they carry intense human interest to all classes is but reasoning in a circle.

In these fields and using the tools for educational work already named the great museums of the immediate years to come are undoubtedly destined to reach a goal of supreme usefulness—"tending directly to humanize, educate, and refine a practical and laborious people" as represented in the democracy of America.—THE EDITOR.



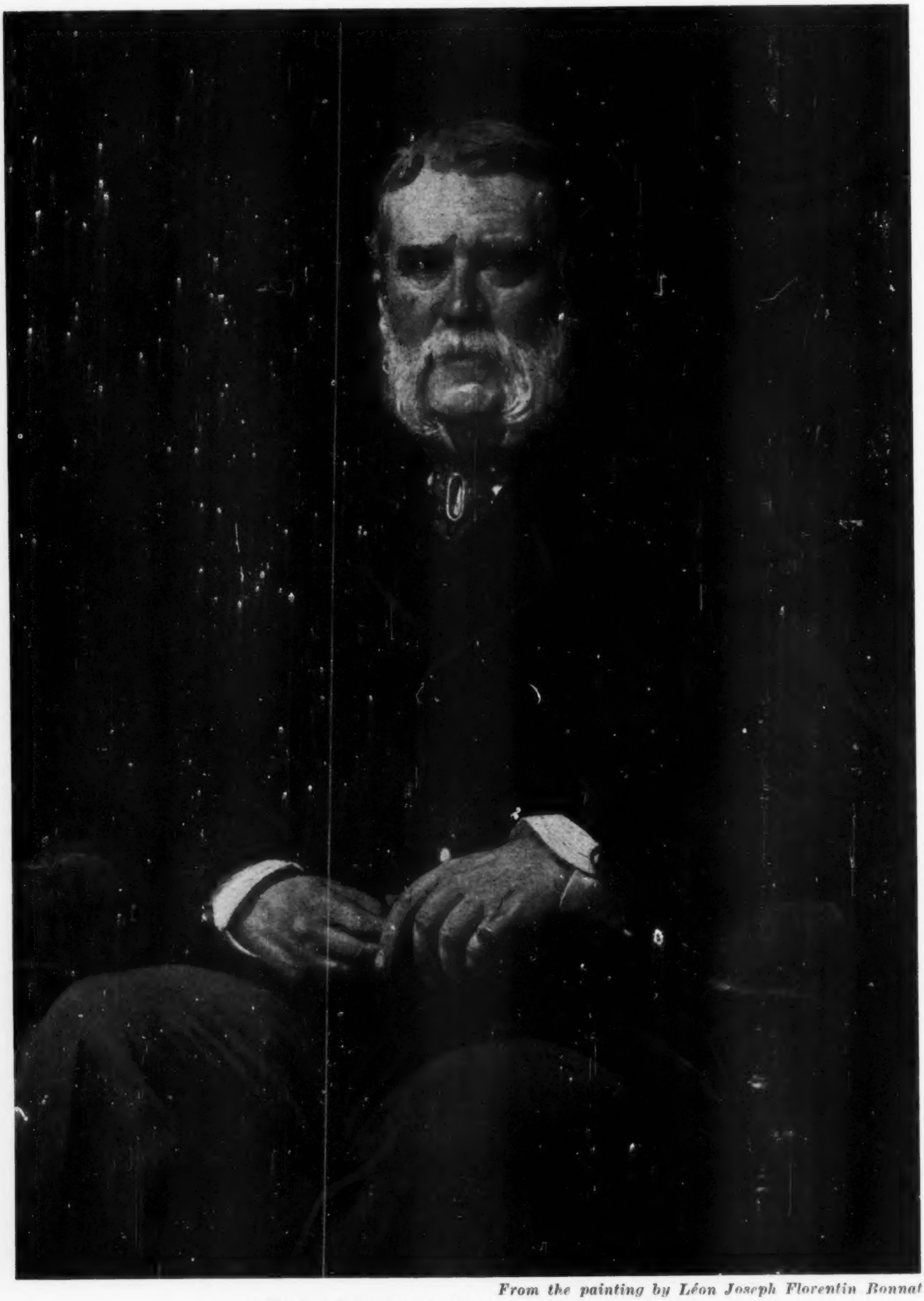


From the painting by Thomas Le Clear

THE AUTHOR OF THANATOPSIS, 1794-1878

William Cullen Bryant, American poet, art counselor, publicist, and journalist (editor of the New York *Evening Post* for nearly fifty years), was chairman at the great meeting for the founding of the Metropolitan Museum of Art, at the Union League Club, Twenty-sixth Street, November, 1869. His address has been much quoted. The following extract was prophetic:

"The growth of our city is already wonderfully rapid [this, fifty years ago]; it is every day spreading itself into the surrounding region, and overwhelming it like an inundation. Now that our great railway has been laid from the Atlantic to the Pacific, eastern Asia and western Europe will shake hands over our republic. . . . Here will be an aggregation of human life, a concentration of all that ennobles and all that degrades humanity. . . . We must be beforehand with vice in our arrangements for all that gives grace and cheerfulness to society . . . to the cultivation of the sense of beauty —in other words, the perception of order, symmetry, proportion of parts, which is of near kindred to the moral sentiments. . . ." *Portrait from the Memorabilia of the Metropolitan Museum of Art*



From the painting by Léon Joseph Florentin Bonnat

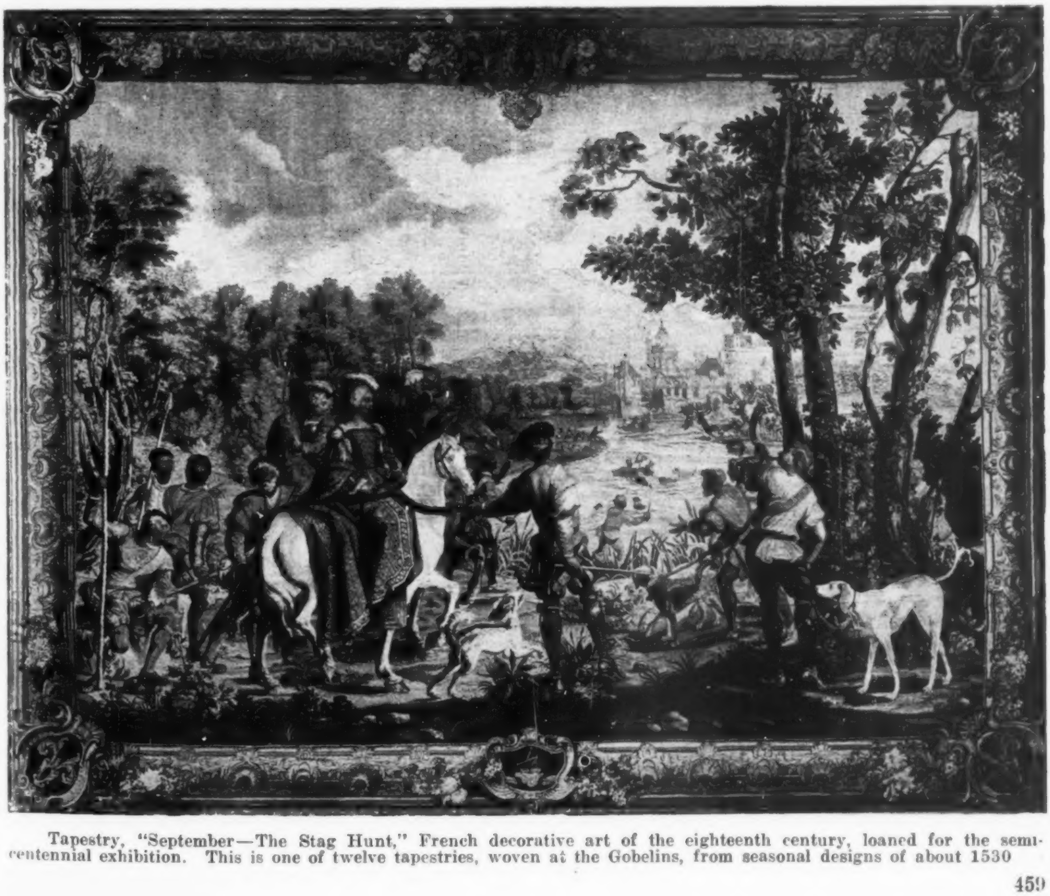
A MAN OF ENERGY, WILL, AND ENTHUSIASM

All honor is given today to the name of John Taylor Johnston, who was appointed president of the Metropolitan Museum of Art at the time of its founding and continued in this capacity throughout the formative period of the institution until 1889. After this he served as "honorary president for life." He owned the most important private collection of paintings in New York City in 1870, which he had opened freely to the people.

He was followed in the president's chair in 1889 by the art collector and banker, a generous friend of the museum for thirty years, Henry G. Marquand. The succession following has been Frederick W. Rhinelander, 1902, J. Pierpont Morgan, 1904, and Robert W. de Forest, 1913. *Portrait from the Memorabilia of the Metropolitan Museum*

George P. Putnam (at the left), 1814–72, represented publishing interests among the men who guided the early years of the Metropolitan Museum. He spoke at the first meeting (1869), was on the original subcommittee of thirteen to draw up plans of organization, and was a member of the first executive committee.

George William Curtis, 1824–92, with a high reputation as author, editor, and lecturer, known generally as a man who used his powers in support of Lincoln, represented with Bryant literary men of note among the museum's early adherents. *Portraits from the Memorabi ia of the Metropolitan Museum of Art*



Tapestry, "September—The Stag Hunt," French decorative art of the eighteenth century, loaned for the semicentennial exhibition. This is one of twelve tapestries, woven at the Gobelins, from seasonal designs of about 1530

JOSEPH H. CHOATE, 1832-1917

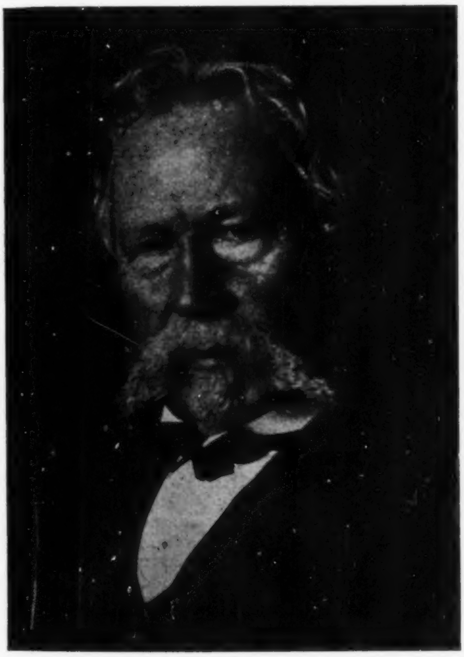
As lawyer and statesman he was an enthusiastic advocate of the underlying educational idea of the Metropolitan Museum, that art is "the vital and practical interest of the working millions,"—thus when the question first arose relative to Sunday opening (inaugurated in 1891), he urged the need of the people. His high legal knowledge served the institution during all the years of his connection, from the founding in 1870 to his death in 1917—as it did also the American Museum of Natural History. It was he who in 1878 drafted the lease for the Metropolitan Museum by which the city became sole owner of the buildings with responsibility for their repair, the museum owner of the collections with sole right to the use of the buildings—a partnership the agreements of which have not been substantially changed since.

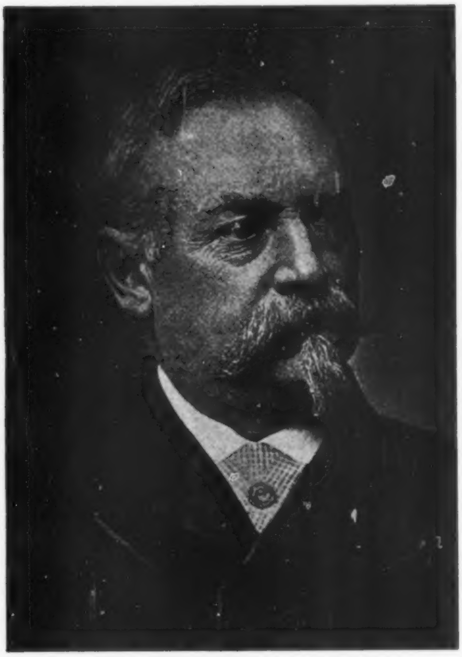
The Metropolitan Museum has just closed its Fiftieth Anniversary Celebration. There have been special exhibitions and ceremonies commemorating the work of men like Mr. Choate. But far surpassing any special celebration is the museum itself as it stands, open and active every day, with all its departments and avenues of work in full progress—notwithstanding the handicaps all public institutions have shared alike in recent years because of difficult financial conditions due to the World War. It is the free character of these institutions, developed in the same cause and spirit as the American Republic, that makes them capable of close entrance into the life of American citizenship

Portrait of Mr. Choate from the Memorabilia of the Metropolitan Museum of Art

Early eighteenth century wood sculpture in the Metropolitan Museum—coat of arms on English limewood

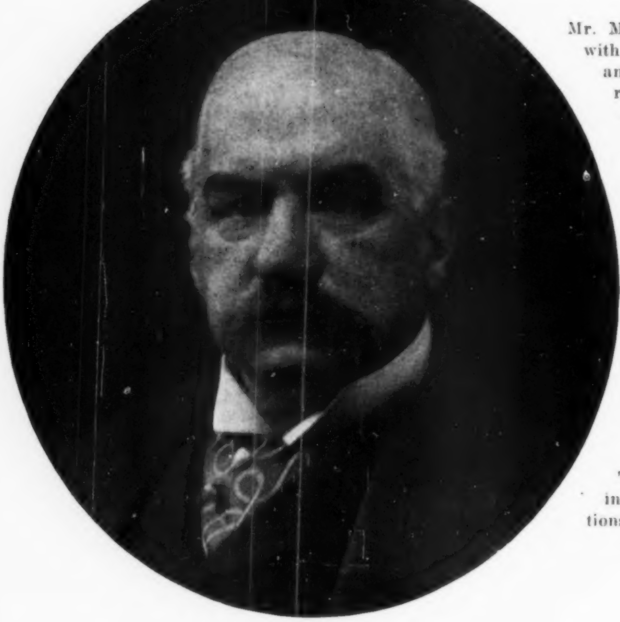
Tapestry, "Immortality," Flemish, about 1500. A loan to the Fiftieth Anniversary Exhibition of the Metropolitan Museum of Art in the summer of 1920





Eastman Johnson (at the left), 1824–1906, portrait painter and delineator of common life in *genre* canvases, was one of the founders and incorporators of the Metropolitan Museum of Art.

Richard Morris Hunt, 1829–95, architect of great distinction, also was among the original incorporators. He was a member of the first executive committee and acted as a trustee from the founding in 1870 until the time of his death. The fountain on Fifth Avenue between Seventieth and Seventy-first streets, executed by Daniel Chester French, was erected to Mr. Hunt's memory in 1898 by the Municipal Art Society of which he was president, the American Institute of Architects, Architectural League, National Sculpture Society, and Century Association. *Portraits from the Memorabilia of the Metropolitan Museum of Art*



Mr. Morgan became president in 1904 with Robert W. de Forest, secretary, and Edward Robinson, assistant director. A new period in the museum's history was soon indicated by successive steps of advance—establishment of new classes of membership, creation of the department of classical art, organization of educational work with the public schools, and of the expedition to Egypt. A new policy gave New York great loan exhibitions such as the works of Augustus Saint-Gaudens (1908), Hudson-Fulton Exhibition (1909), and Whistler Exhibition (1910), and gave student artists great freedom in time and privilege for copying paintings and sculptures. The Pierpont Morgan Wing, opened in 1918, contains the many collections he gave

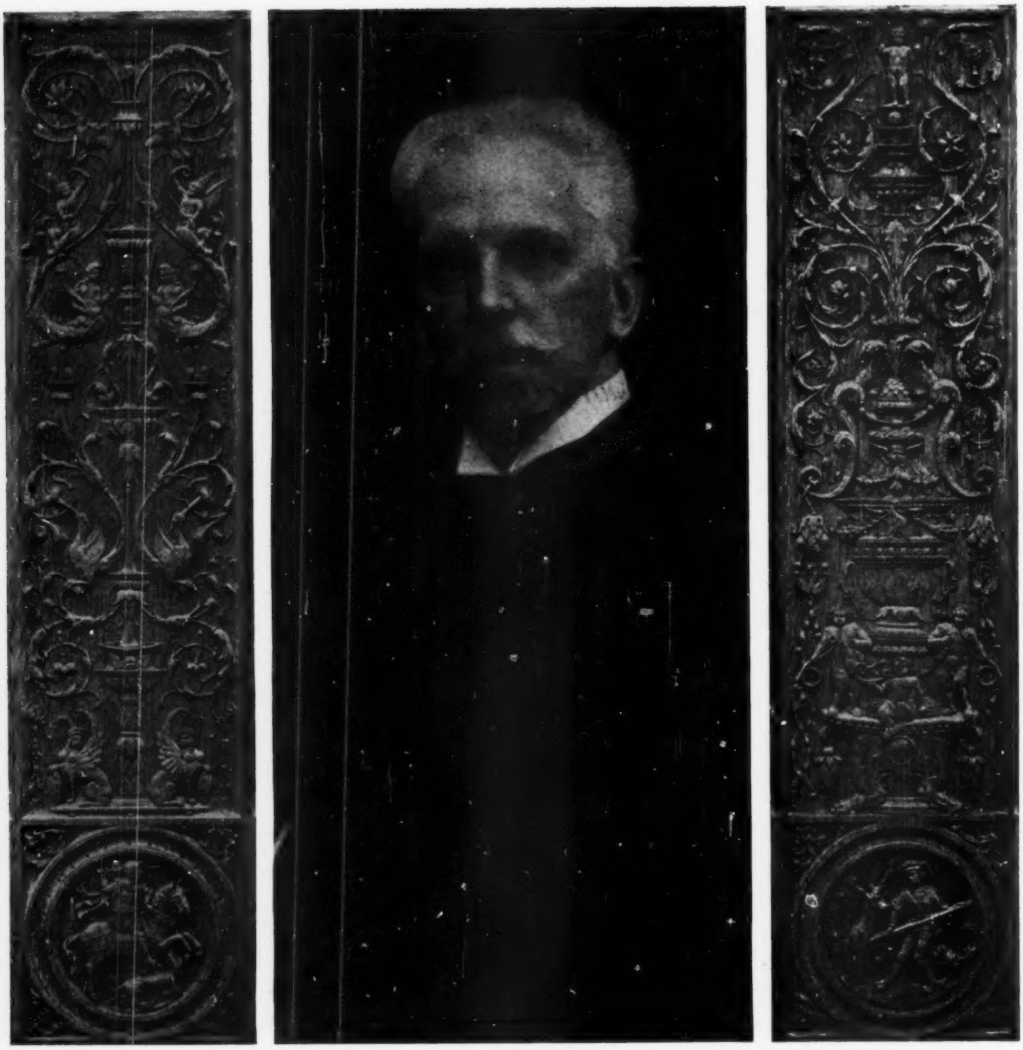
J. PIERPONT MORGAN, 1837-1913

Mr. Andrews, distinguished bibliophile, was closely connected with the Metropolitan Museum from 1878 until his death in 1920. His great knowledge and love of books turned his interest to the building up of the institution's art library. He was librarian for many years and later honorary librarian. His annual report in 1881 just after the museum moved into the Central Park building listed 447 books and pamphlets in the library. Today this library covers the literature of architecture, sculpture, painting, etc., so extensively that it serves a large usefulness to many tens of thousand readers annually. *Portraits of Mr. Morgan and Mr. Andrews from the Memorabilia of the Metropolitan Museum of Art*

WILLIAM LORING ANDREWS, 1837-1920

CARVED WALNUT WOOD, FRENCH, EARLY EIGHTEENTH CENTURY

The collections of the Metropolitan Museum of Art are very rich in carvings in relief and in the round on various kinds of wood and representative of the art of many countries (see oak carving, French, pp. 457 and 464)



EDWARD ROBINSON

Director of the Metropolitan Museum of Art, New York City

Mr. Robinson became assistant director in 1905, and, on the withdrawal of Sir Caspar Purdon Clarke from the directorship in 1910, accepted the higher position. He had become connected with the museum in 1891 while director of the Museum of Fine Arts, Boston, taking charge of the work of collecting a complete series of casts, historically arranged, for the department of classical art.

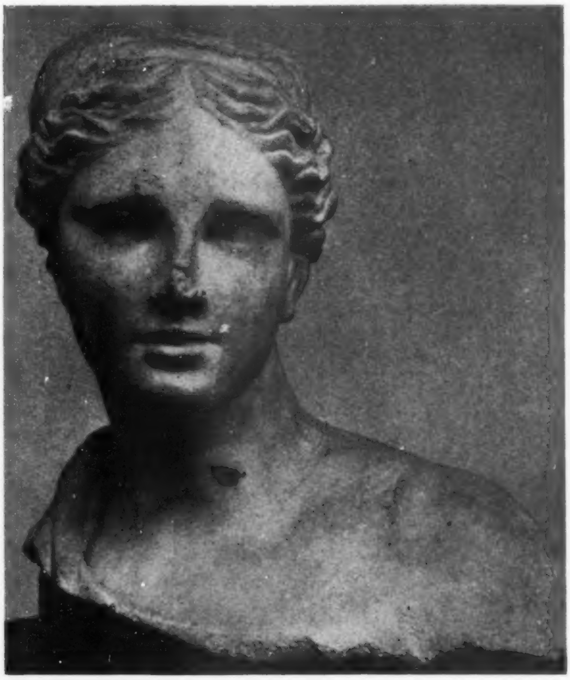
Mr. Robinson's ideal for the Metropolitan Museum he states as educational efficiency, and the work of each department is formulated to meet this ideal. The collections are being built up on a scientific plan and exhibit the masterpieces of different countries and times, not only so as to be attractive and accessible for student artists and visitors, but also in such relation as to teach the history of art.

The museum points to the Egyptian galleries as an example of its recent growth and method. From relatively few unrelated objects exhibited in a single corridor, the Egyptian collections have developed until they present a historical sequence through fourteen galleries, covering from 4000 B.C. to 700 A.D. The excavation work of the museum's expedition in Egypt has been continuously carried on even through the years of the war, to the great enrichment of America's stores of original Egyptian art.

The development of the department of arms and armor (1912–20) is also cited. Under efficient organization, with expertly selected purchases and loans of great value, with rich gifts such as the collection of William Henry Riggs, also with exhibits covering the problem of armor as developed during the world war, this gallery of the museum today offers an unparalleled opportunity for study of the various phases of this subject.

Educational efficiency within, coupled with coöperation in educational and industrial work without, is particularly the policy of all great American museums today. Many of these are relatively of the same age, about fifty years. The demand of the time which brought about the incorporation of the Metropolitan Museum of Art and the American Museum of Natural History, gave rise also, for example, to the Museum of Fine Arts, Boston, and the Art Institute, Chicago. Through official representatives to the Golden Jubilee of the Metropolitan Museum, 1920, these sister institutions sent messages of greeting and cordial good wishes

Chinese vase, Sung Dynasty, loaned for the Fiftieth Anniversary Exhibition. Hard, gray, porcelanous ware (Tz'ŭ-chou), covered with white slip and transparent glaze, the slip partly etched away to leave a large floral design



LOAN IN CLASSICAL ART

Head of a girl, Greek, fourth century B.C

That the Fiftieth Anniversary Exhibition of the Metropolitan Museum brought such richness of loans in Gothic, Renaissance, eighteenth century, and modern art, and but few in classical art, emphasizes that the art collections of America, contrasted with those of England, for instance, are not strong in the classical line—owing to the difficulty there has been in recent times to obtain Greek and Roman works of first quality. This marble head expresses the spirit of Praxiteles in Greek contemporary art, reflecting his style and carrying much of the delicate beauty of his work. The head was evidently part of a statue trimmed to its present shape in recent years

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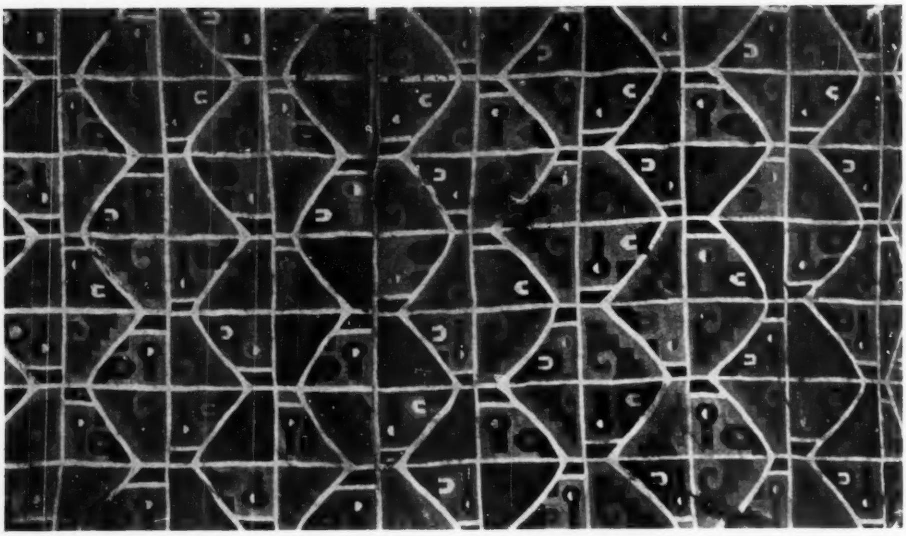
"And what should be the policies of the Metropolitan Museum in the future, so that our successors, when they come to celebrate its hundredth anniversary, may do so with the same satisfaction with which we celebrate its fiftieth? Strict adherence, in my judgment, to the policies of the past, with difference of emphasis, perhaps, and an open-minded readiness to meet changes in the public sentiment of the future."—*From address by President Robert W. de Forest*



Aside from the wonderful technique of Peruvian tapestry, the richness of its color is a marvel to the modern expert. Interment for a millennium in no way dims the colors, which are mostly from vegetable dyes, and, although intense, are never displeasing to the eye. The above design, which is typically Peruvian, consists of a repetition of the same geometrical motive arranged in different quarters of a series of truncated rhombs. The preservation of the cloth for such a great length of time is due to the fact that it was buried in the dry, nitrous sand of the Peruvian desert coast where rain seldom falls. This piece is from the collection of Sr. F. G. Estrada, recently purchased for the American Museum

A Prehistoric Poncho from Nazca, Peru

THE American Museum's series of prehistoric objects from graves in Nazca, Peru, has just been augmented by the purchase of Sr. F. G. Estrada's collection consisting of 130 specimens, mostly textiles. These comprise broad and narrow ribbons, coca bags, belts, slings, etc. The prize piece of the collection is a tapestry poncho. The warp is of cotton, covered by the weft of vicuña wool yarns.

Aside from the beauty of the Nazca webs their technique never fails to interest and astonish textile manufacturers and experts. A careful examination of one piece of tapestry in the collection brought to light the fact that it contained 330 vicuña weft yarns over 42 cotton warps to the inch. Experts tell me that we seldom put in as many as 100 weft yarns of wool to the inch.

Tapestry has been defined as darning on bare warps. As many bobbins are required as there are to be colors in the fabric. Selecting the required color for the first few warps on one side of the loom, the weaver laces it in, then takes another bobbin, and so on across to the other side. In this way the designs are built up, a pick at a time, and not each formed separately. When two areas of different colors come together on parallel warps we see the slit characteristic of tapestry.

In this poncho, as in other prehistoric Peruvian textiles, the great charm lies in color schemes. In these there is never found an arrangement of colors that offends the artistic eye. The whole scheme of the decoration is taken in a high key, but the various shades of red and yellow are so soft and pleasing that we do not at first realize how intense they are.

The colors used by these ancient people were mostly made from vegetable substances, and our modern color boxes contain few that match them, as thousands of artists and design students who have worked from these textiles can testify.

To copy the poncho under consideration is, in a way, like painting a brilliant sunset from nature. The result probably will be disappointing while in presence of the original, but will seem to look much better the next day when removed from its proximity.

The design is a sort of diamond-shaped figure (truncated rhomb) enclosed in white lines, and by other white lines divided into quarters. Each quarter contains a number of figures which never change in form, although their positions and colors and those

of the quarter in which they occur vary in each succeeding design. This repetition of a design in different color schemes is a characteristic of Peruvian decorative art. The colors used in the poncho are yellow, greenish yellow, dark buff, carmine-red, dull red, brown, old rose, magenta, purple, green, black, and white.

The greater part of the Peruvian coast region is a desert where rain is all but unknown, and textiles buried in the dry, nitrous sand suffer little or no deterioration. After a lapse of one thousand years or more they come from these graves as strong in texture and with the colors as bright as the day they were buried with the dead. They are found on the mummy or beside it, with such objects as were prized by the individual in life and such as it was thought would be useful in a future state.

Nazca lies about 220 miles to the south of Lima. The whole valley in which it is situated is hot and dry. The only water is from a small river that is dry part of the year, and sometimes contains no water at all for several years. About the only indigenous vegetation to be seen is algarroba trees and cotton plants. Notwithstanding these conditions there is abundant evidence that the Nazca Valley supported a large population in prehistoric times. How was food enough obtained to support so many people? This is one of the Peruvian puzzles that has never been solved. There is not the least evidence that conditions have changed in this region, yet here flourished one of the three great culture centers, the others being at Tiahuanaco and Trujillo.—CHARLES W. MEAD, Assistant Curator in Anthropology, American Museum.

Anthropology and Geology in the Pan-Pacific Scientific Conference

Report by the delegates from the American Museum, Dr. E. O. Hovey and Dr. Clark Wissler

THE first Pan-Pacific Scientific Conference for the consideration of research in the Pacific met in Honolulu August 2–20, 1920, at the invitation of the Pan-Pacific Union. The program and preliminary organization were placed in the hands of the National Research Council of the United States and were referred to the Committee on Pacific Exploration, of which Dr. J. C. Merriam is chairman. The members of this committee, not being able to attend the conference, delegated their responsibilities to Dr. Herbert E. Gregory, of Yale University and director of the Bernice Pauhai Bishop Museum at Honolulu, and Dr. Clark Wissler, of the American Museum and chairman of the Division of Anthropology and Psychology of the National Research Council, as a subcommittee. The plan submitted by this subcommittee was adopted by the conference as its scheme of organization, declaring itself to be international in scope and representing the scientific men of all the nations in and around the Pacific.

Sixty delegates were in attendance, representing the Territory of Hawaii, the Philippine Islands, Canada, Japan, England, Australia, New Zealand, and the United States of America. It was proposed that the members of this conference should constitute a general committee for the formulation of a research program for the Pacific with a view to coördinating the scientific activities of all the nations concerned. To facilitate this program a number of sectional committees were formed.

Geology and its related sciences were represented by the following delegates:

E. C. Andrews, chief of the Geological Survey, New South Wales; William Bowie, chief of the Division of Geodesy, U. S. Coast and Geodetic Survey, Washington, D. C.; R. T. Chamberlin, professor of geology in the University of Chicago; Leo A. Cotton, professor of geology, University of Sydney, Australia; Joseph A. Cushman, director of the Boston Society of Natural History; George R. Davis, geographer, U. S. Geological Survey, Washington, D. C.; Rue H. Finch, seismologist, Hawaiian Volcano Observatory, Hawaii; Herbert E. Gregory, professor of geology, Yale University, New Haven, Conn.; Gilbert Grosvenor, president of the National Geographic Society, Wash-

ington, D. C.; E. O. Hovey, curator of geology and invertebrate palæontology, American Museum of Natural History, New York City; T. A. Jaggar, Jr., director, Hawaiian Volcano Observatory, Hawaii; G. W. Littlehales, hydrographer, U. S. Hydrographic Office, Washington, D. C.; Miguel S. Maso, seismologist, Philippine Weather Bureau; Fusakichi Omori, professor of seismology, Imperial University, Tokyo, Japan; H. S. Palmer, assistant professor of geology, University of Hawaii; Henry C. Richards, professor of geology, University of Queensland, Australia; Arnold Romberg, seismologist, University of Hawaii; Warren D. Smith, professor of geology, University of Oregon, Eugene, Ore.; C. A. Sussmilch, director, School of Technology, Newcastle, New South Wales; J. Allan Thompson, director of Dominion Museum, Wellington, New Zealand; T. W. Vaughan, geologist, U. S. Geological Survey, Washington, D. C.; R. L. Walker, oceanographer, Pearl Harbor, Honolulu; H. S. Washington, geologist, Carnegie Geophysical Laboratory, Washington, D. C.; H. O. Wood, seismologist, National Research Council, Washington, D. C.; N. Yamasaki, professor of geology, Imperial University, Tokyo, Japan.

The principal prepared addresses under geology and geography were connected with the discussion of the topic "The Framework of the Pacific," presented by E. C. Andrews, R. T. Chamberlin, F. Omori, and William Bowie; "Ocean Currents and Their Significance," discussed by Paul Bartsch, G. W. Littlehales, G. F. McEwen, and N. Yamasaki; "Volcanism in the Pacific," discussed by T. A. Jaggar, Jr., and H. S. Washington; "Seismology in the Pacific," discussed by F. Omori and H. O. Wood; "Mapping the Pacific," discussed by William Bowie, G. W. Littlehales, and G. R. Davis.

Resolutions adopted as an outgrowth of the conferences urged, among other things, the prosecution of geological surveys of critical insular areas in the Pacific Ocean; emphasis was placed upon the importance of coöperation among the different geological workers in the Pacific region, and the establishment of a central scientific bureau for the dissemination of volcanic and seismologic studies was earnestly advocated.

In anthropology, the sectional committee, in conformity with the policy of the conference, undertook the formulation of a plan for the development and coördination of anthropological research in the islands of the Pacific, particularly in Polynesia. Polynesia was emphasized because the section received a formal request from the trustees of the Bishop Museum in Honolulu for detailed recommendations for the organization of their own investigations in Polynesia, for which funds have recently been provided. It proved impossible to complete the work of the section during the three weeks allotted, but provision was made for the final formulation of its recommendations under the direction of the section officers.

The conference held daily sessions, giving the entire morning of each day to the principal sciences concerned in Pacific research. These sessions were attended by the whole conference and the discussions freely participated in. One entire morning was given to anthropology, the presiding officer being Dr. Frederick Wood-Jones, of the University of Adelaide. The formal presentations were as follows:

Clark Wissler, "The Chronological Problem in the Pacific"; A. L. Kroeber, "Peoples of the Philippines"; L. R. Sullivan, "The Racial Problem in Polynesia"; A. M. Tozzer, "Race Mixture in the Pacific"; J. F. G. Stokes, "Distribution of Culture Traits in the Pacific as Illustrated in Featherwork"; T. G. Thrum, "Polynesian Archæology."

The anthropological representation in the conference included:

United States: Clark Wissler, A. L. Kroeber, A. M. Tozzer, Gerard Fowke, L. R. Sullivan, R. T. Aitken. Territory of Hawaii: W. T. Brigham, J. F. G. Stokes, T. G. Thrum. Australian: Frederick Wood-Jones. New Zealand: J. Allan Thompson. Philippine Islands: No anthropologist accompanied the Philippine delegates, but the subject was represented in the section by E. D. Merrill, director of the Philippine Bureau of Science. Japan also sent no anthropologist, but the work of Japanese anthropologists was presented by Dr. N. Yamasaki, professor of geography, Tokyo Imperial University. Dr. K. Kishinouye, the celebrated Japanese zoölogist, who has made a special study of Japanese shell heaps, also took a prominent part in the meetings of the section.

Objects That Symbolize the Common Life in Tibet

With reference to a new and very valuable collection recently obtained by the American Museum from southern Tibet

THOSE who are in the habit of visiting the anthropological halls of the American Museum to study the customs of far-away peoples will be glad to learn of a recent valuable accession from Tibet.[1] The collection was made by a medical missionary, the Rev. H. B. Marx, through a period of sixteen years' residence at a Moravian mission on the southern Tibetan border. The mission buildings are on the Indian side, suffice it to say, not on Tibetan soil, and that Dr. Marx has been able not only to maintain cordial relations with this unfriendly country, but also to bring together a collection of objects representing the common life there, reflects on both the high character of his personality and the gratitude the Tibetans have felt for the medical service he has given.

The Tibetans have always borne toward the rest of the Orient excessive exclusiveness both political and religious, especially during the nineteenth century and later when elsewhere civilization has been rapidly advancing, which leaves them today in the anomalous position of a living but almost fossil race. Even their country, a million miles square and the highest of the globe, with valleys ranging from 12,000 to 17,000 feet above the sea, is little known. From India at the south they have kept a commanding barrier by the almost unscalable mountains—as well as by their aggressive, suspicious nature and very different social life. Dr. Marx, however, from the mission at Poo, India, was allowed to penetrate considerable distances in different directions, and the collection which he has brought out has been selected with thought for high scientific value in depicting national custom.

The tea-drinking habit in Tibet, for instance, is suggested in the paraphernalia for making "buttered tea": a low table of red and black lacquer (behind which the Tibetan sits with crossed legs on the floor or on a small woolen rug of Tibetan weaving); either a wooden or a china cup for the tea, with a metal saucer-like stand and a cover; the teapot of brass or silver, attractive in shape and elaborately decorated; and the small churn with metal ornamentation. The hot tea is mixed with rancid butter and ground barley into a kind of broth, the so-called buttered tea, or perhaps is compounded with a larger amount of barley into small brown cakes. That the cup fits into a covered metal box and the table collapses into a form convenient for transportation intimates the habitually large amount of slow travel there is in Tibet by primitive methods from one remote center of population to another. Tea is imported from China in enormous amounts. The official report of duty covers the entrance of more than ten million pounds annually. Most of this is of an inferior quality, compressed into large bricks of about five pounds weight, which are so universally used throughout the realm that they have come to be passed as currency.

One can read correctly very much of the life of the Tibetans from these isolated objects. Hobbles, stirrups, and racing harness tell the very considerable part the Tibetan ponies take in pastime and travel; the woolen industry is illustrated from clipping the wool through spinning and weaving to the finished shawl. There are bleeding cups and crude lancets and the like to reveal the primitive state of medicine and surgery; pipes, bags, and boxes explain the large use of tobacco and opium; and there are various musical instruments, the oboe of the beggars, the primitive guitar and flute, and especially the drum and bell of the noisy music of the lama festivals.

It would be evident from the collection,

[1] Presented through the generosity of Mr. J. P. Morgan, New York City.

SUGGESTIVE OF THE PREVALENT TEA-DRINKING HABIT IN TIBET

The teapot is of Chinese importation. The Tibetans do not make any ornamental metal work. The table of red and black lacquer spreads out into considerable size or collapses into form convenient for transportation on the long, slow journeys the Tibetans make over their inhospitable and thinly settled country. Also, the bowl for tea fits into a covered metal box (at the left) for safety during travel. "Buttered tea," a staple food in Tibet, is made by mixing hot tea with rancid butter and stirring into this ground barley to broth consistency—or in larger amount to form small cakes

LAMA COSTUMES WORN IN A CEREMONY FOR "DRIVING OUT THE DEMON"

At the left are the musicians with drum, cymbals, and bell. One lama carries the lasso to catch the fleeing demon, a second the chain to bind him, a third the skeleton club to deal the death blow, a fourth the sacred lama dagger and the skull in which is caught the blood to serve as a vigor-giving drink to the lama. This fourth lama (at the right) is wearing the very sacred mask of the five skulls, representative of slain demons, and the breast regalia of carved lama bones. The ceremonial robes are of heavy silk, gold embroidered. These objects are all in the possession of the American Museum, which hopes at some time in the future to build a group depicting the demon dance in the court of a Tibetan temple (see page 472)

too, that religion plays a large part in the life of Tibet, and that this religion[1] tends toward sorcery, ritualism, and magic. There are clay idols and the copper molds for making them; there are amulets for protection against sickness, bad dreams, and fears in the dark, or to be worn during what they consider the "dangerous" years of life, a dozen years apart (thirteen, twenty-five, thirty-seven, forty-nine, sixty-one, seventy-three); there are nuns' rosaries carved in shell; a prayer wheel is filled with a sheaf of thin round leaves of paper, each printed with many repetitions of a common prayer, ready to be brought by the whirling of the wheel to the attention of the Merciful One begging him to have the world in mind and help all human kind; there is a prayer stone with its engraved prayers, such as cover the stones in the thousands of prayer walls in Tibet, all addressed to the same Merciful One for the good of mankind.

Sacred relics called "potted lamas" intimate the strong barbarous element in a people saturated in the horrible incident to life and death. These objects are made of crushed human bones and clay, referring to the Tibetan custom of disposing of their dead priests by throwing aloft small portions of the flesh cut from the body to be caught by the circling birds of prey, and crushing the bones to be mixed with clay and pressed by means of metal molds into these relics.

The collection contains the powerful lama dagger carried in a ceremonial dance of the lamas called "driving out the demon." The dancers, called "demon dancers," represent the warriors of Tibet's ancient demon worship. There are the lasso used by the warrior to catch the fleeing demon, the iron chain which fetters him, the skeleton club which deals the death blow, and the skull in which is caught the blood to serve as a vigor-giving draft to the warrior.

All these objects, together with the masks and the silk and gold-embroidered robes of symbolic colors worn by the officiating lamas in the ceremony, are a part of the new accession. The museum will have under consideration the possibility of exhibiting them at some time in the future, with the assistance of Dr. Marx, on figures in an anthropological group, thus portraying one stage in the demon dance just as it takes place in the court of the Tibetan temple. Fortunately for this, the collection contains also the regalia consisting of ornamental apron and breastplate made of carved bones of sainted lamas; and also the very sacred mask of the five skulls, representing slain demons, which is worn by the lama who carries the sacred dagger. This ceremony and many of the others of Tibetan religious festivals performed by the lamas, it is said, present a considerable analogy to various mediæval mystery plays.—THE EDITOR.

[1] The religion of Tibet is a combination of old savage demon worship and modern Buddhism.

Sacred Tibetan relics molded from clay mixed with the crushed bones of sainted lamas. Such objects, together with prayer wheels, prayer stones, and the like, are suggestive of the large part religion plays in the common life in Tibet,—a combination of ancient demon worship and modern Buddhism

Three-toed Horses[1]

A FOSSIL RECORD THAT PROVIDES DIRECT EVIDENCE OF EVOLUTION

By W. D. MATTHEW

Curator of Vertebrate Palæontology, American Museum

THOSE who are familiar with Macaulay's *Essays* will recall the way in which he makes the review of some book a peg on which to hang a learned and brilliant discussion of the whole subject to which the book relates. That, in a way, is what I intend to do here—omitting the adjectives—as it is convenient to adopt his method for the present essayette and to use Professor Osborn's monograph as a text.

This memoir is in fact a very elaborate, although by no means a complete account of the three-toed horses of America, very thorough and authoritative, and admirably illustrated. Every described species is recorded, with the original figures and the essentials of the original description refigured and redescribed where there is occasion, its geological formation and locality exactly given, and referred to its proper relations as now understood. In addition, a great number of new species or specimens are described and figured, much more complete than the fragmentary types on which early studies were based. Diagnoses of the genera are given, and the systematic revision is preceded by an account of the formations in which the various species have been found and their correlation, and an all too brief discussion of the structure of the molar teeth in the three-toed horses.

The incompleteness of the memoir consists in its failure to describe or even mention the great bulk of undescribed material, prepared and partly studied and identified, in the American Museum and elsewhere. Foreign students quite fail to realize the existence of this unpublished material and the important bearings that it has on problems of migration and distribution.

The volume is essentially a record of facts. Professor Osborn has throughout avoided discussion of the theories and conclusions relating to the evolution of the horse and cognate subjects which he has so luminously and extensively treated elsewhere. It presents the foundation of material evidence on which such theories are based, and as such it is invaluable to all future researches in this subject, although too technical for the amateur or superficial student, and not intended for the general reader.

What were these three-toed horses anyway? Why are they so important or so interesting that literally thousands of scientific papers have been written about them and that so busy a man as Professor Osborn can find time to prepare this elaborate memoir for the help of future students?

Briefly, they are thus important because they afford one of the best records by which to test the truth of the theory of evolution.

The theory of evolution—commonly but wrongly called "Darwinism"—is an attempt to explain the present diversity of living beings and their various resemblances and differences in structure as due to their descent from common ancestors and the slow, gradual changes in each race in adaptation to its particular mode of life. The doctrine of natural selection—Darwinism properly so called—gives as the cause of these changes the gradual accumulation through innumerable successive generations, of such minute differences as we find always exist between individuals and tend to be inherited by their offspring.

All the evidence for evolution found in the anatomy and structures and habits of animals, in their relationship and distribution, in the growth and development of the individual, in the breeding and selection of domestic animals and of plants, and in the so-called "experimental evolution" which has converted into a science the practical knowledge of the breeder, is, after all, indirect evidence. However uniform its inferences, however overwhelming its weight, however perfectly and admirably it explains innumerable details of structure and habit for which no other reasonable explanation can be found, it would be as nothing if palæontology were against it. If the actual remains of fossil animals showed that they

[1] "The Oligocene, Miocene, and Pliocene Equidæ of North America." Iconographic Revision by H. F. Osborn. *Memoirs of the American Museum of Natural History*, Series II, No. 1, issued 1918.

had always been as they are now since they first appeared on the earth, then, indeed, we would have to sweep aside the beautiful theory of evolution with all the exquisite perfection of its explanations of every tiny detail in the complex structure of the higher animals, as an iridescent dream. We would have to say to the anatomist, to the embryologist, to the experimental evolutionist: "Oh, yes! Your interpretations and analogies and experiments are ingenious and interesting, but you can't prove evolution by them for they are in conflict with the plain facts. The record of what actually has happened shows that species *did not* come into being that way. They were created in the beginning just as they are."

But the fossil record, this plain, direct, and unalterable record of what *did* happen during the past history of the earth, *does* prove evolution, and wherever it is complete enough, it proves it so directly and conclusively that it removes it from the category of theories to that of facts. It is, indeed, a very incomplete and fragmentary record. It owes its preservation and existence rather to the chapter of accidents than to the normal cause of circumstances. But, whenever there is anything approaching a consecutive detailed record of any race or type of animal, it becomes perfectly evident that the race or type has not come into existence in its present form, but has changed through numerous small or minute gradations from an original type which is hardly or not at all distinguishable from the original form that gave rise to other races or types of animal now widely different.

In brief, we may compare the history of animal life to a tree. The modern animals, separated and distinct in varying degrees and in varying directions, represent the tips of the upper branches. As we follow them down, guided by the geological record of past faunas, we find the separate twigs united, then the larger branches, and finally, if the record would carry us that far, the great boughs or primary branches would come together in the one trunk which is the primitive beginning whence they all arose. In addition to the branches which have survived to the present day there are many branches, great and small, and innumerable twigs, that have become extinct at various epochs in the past. Such is the picture that we build up from the glimpses of the past history of life vouchsafed to us by the record, graven in stone, immutable and unforgetable, that is set before us.

The authenticity of these "documents," as the French are fond of calling fossil specimens, cannot be challenged save by the ignorant. It is perhaps not known to everyone that it is the structure, not the form of a fossil bone that proves it to be authentic. Its form can be mimicked, its peculiar structure it is impossible to imitate artificially, nor does nature ever produce anything else resembling it. Historical documents may be forged. Nature's documents cannot.

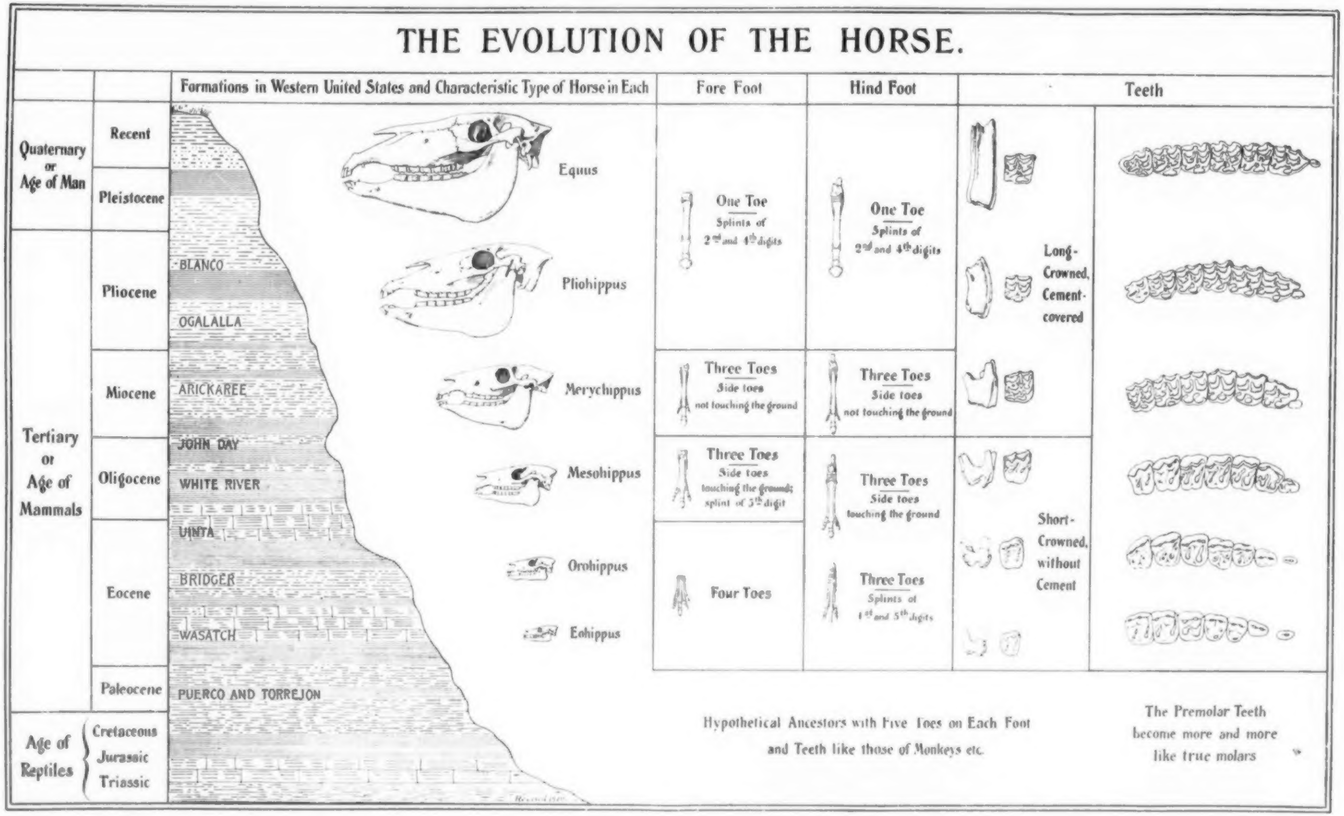
It is true that the geological record of successive stages may sometimes be inexact or incorrect. The succession of the geological formations is determined by the fact that one overlies or overlaps another. Obviously the one on top must be of later age, unless the world has been turned upside down in that particular region.[1]

But sometimes the formations are in different regions and cannot be directly connected up. In such cases we have to rely on other and less conclusive evidence, and mistakes may be, and have been, made. The earliest serious study of fossils showed, however, that certain formations were characterized by certain kinds of extinct animals, and that these fossils were found only in those strata; above and below they were replaced by other species, related but distinct.

This fundamental fact has been verified by a century and a half of research. It can be verified again by anyone who will take the trouble to go out into the field and collect fossils. No one would be more prompt to report an exception than the scientist; for such a discovery would make him famous. But no real exception has ever been found. No species whose structure is sufficiently complex for its fossil remains to show the traces of change persists wholly unaltered through any considerable portion of geological time.

The geological record is a grievously incomplete one. For the most part it must be built up—as is the historic record—by comparison and deduction from documents

[1] There really are such cases in the Alps and other mountain regions, where a succession of strata is tipped up on edge and occasionally actually overturned. How such overturns occur and how they are recognized is explained in geological textbooks.



The ancestry of the horse and the slow general development to the species known today afford one of the most complete fossil records by which to test the theory of evolution. Here is told a plain, straight story of what *did happen* during the past history of the earth.

The illustration, read from the bottom up, indicates this evolution from early geological periods (at the left), with continual increase in size of the horse as represented in the column of skulls, decrease in the number of toes as shown in the drawings in the middle two columns, and change of the premolars from a short-crowned condition without cement to long-crowned cement-covered teeth very like the molars

preserved. Fortunately we do not have to dispute their authenticity and seldom to question their provenience. But there may often be doubts of their exact significance. It is only here and there, in certain groups of animals and for certain portions of their history, that our "documents" are complete and abundant enough to prove directly the evolution of the race. The best evidence of this sort is to be found among the invertebrates, especially among mollusks, which include many cases where the gradual change in a race can be followed by numerous specimens from each stratum.

But while the evidence of these invertebrates affords conclusive proof of evolution to the palæontologist, it is not always convincing to the layman. Many people may be willing to admit that one species of clamshell has changed gradually into another, but they will deny vigorously that a horse and a tapir are descendants of a common ancestral stock, and angrily resent the imputation that they themselves are blood relatives of the chimpanzee and the gorilla. Such a position is illogical, if they only knew it, for if the proofs of evolution in the anatomy of the lower animals are shown to be in accord with the facts of their past history, then the much stronger evidence in the anatomy of the higher animals must mean the same thing in their case. But it is natural enough, for the objections to evolution center around the descent of man, and the average anti-evolutionist will hardly see that his traditional view is endangered by anything so remote as the humble mollusk.

The evolution of the horse, however, comes near enough home to shake his confidence if he is opposed, or to assure his belief if he is in favor of the theory of evolution. It is not the record in which we are most interested, namely, that of the evolution of our own race. But it is that of one of the most familiar domestic animals, the changes in the structure of the skeleton are obvious and the reasons for them easily understood, and the record of the evolution of the race is a fairly complete one so far as it goes. A brief sketch of the facts in the case may be in order.

The modern horses, asses, and zebras form a little group of animals very much alike save for differences in size, in color, and in surface markings, and still closer together in all the details of their skeleton construction. The skeleton, while it has the general characters common to all the higher quadrupeds and man, is characteristically different and peculiar in many particulars, especially in the construction of the head, of the teeth, and of the feet.

By comparing the skeletons of horse and man as shown in the group at the front of the Horse Alcove in the American Museum, one can see that the bones of the skeleton correspond throughout and have the same relations, but differ very widely in proportions and form. The head of the horse is nearly all face with long jaws and comparatively small brain. The head of the man is chiefly brain case, the jaws very short, and the face relatively small. The horse has a long neck and deep trunk, the man a very short neck and wide trunk. The tail in man is reduced to an obscure vestige. The shoulder blade in man is wide and short with a collar bone bracing it against the breastbone. In the horse the shoulder blade is long and narrow and there is no collar bone. The pelvis in man is a wide, capacious basin that aids in the support of the internal organs. In the horse it is a sort of rack on which the powerful limb muscles are fastened. The limb bones in man are long and loose-jointed, in the horse short, compact, with tight joints that permit of but limited movements—but much more powerful. The outer bones of forearm and shin (ulna and fibula), complete and separate in man, are incomplete in the horse and consolidated with the inner bones (radius and tibia). But it is in the feet that the contrast is most obvious. The wrist of man corresponds to the "knee" of the horse's fore leg, and the ankle to the "hock" of the hind leg. But instead of the short, spreading hand or foot of man with its five digits, the horse has a long, slender foot, composed of only one complete digit, corresponding to the middle finger or toe in man with rudiments of the second and fourth digits known as splint bones. And it is quite literally true that the horse walks upon the tips of its finger nails, for the hoof, not preserved in the skeleton, is the representative of the fingernail or toenail of man.

The object of these contrasts is evident. In the horse the limbs are adapted solely for locomotion on all fours, and especially over open ground. Speed and endurance are gained by lengthening the lower ends of the limbs, stepping upon the tips of the toes,

and concentrating the weight upon the middle toe. The superfluous parts have disappeared. In man the hind limbs are the sole organs of locomotion, but in order to maintain a steady upright pose, it is necessary to keep the heel on the ground, and the wide sole and short spreading toes are suited for travel over rough ground or in the forest. The fore limbs, released for purposes of grasping and holding objects, have become specially adapted thereto.

The teeth of horse and man are equally in contrast. In man they form a continuous semicircular row, thirty-two in number, all of them very short crowned, the molars with a flattened crushing surface, the front teeth with cutting edge, the others intermediate. In the horse the teeth are more numerous, thirty-six or forty according to sex (the canine teeth are usually absent in the female), with occasional rudiments, "wolf teeth" of the first premolar, that if all present bring the number up to forty-four. The front teeth are separated from the cheek teeth by a wide gap; and all the teeth, but especially the cheek row, have very long, or rather high crowns, which keep on growing in the jaw as their surfaces are worn down. The grinding surface shows a very complex structure or *pattern* of crests of hard enamel alternating with softer dentine and "cement" which serves to prevent the surfaces from wearing smooth and makes it effective in triturating the food.

The reason for these differences in the teeth is not far to seek. Our food requires but little chewing; cutting off in morsels and a moderate amount of crushing suffice; and there is consequently no great wear on the surface of the teeth. The food is conveyed to the mouth by the hands (with or without the aid of implements) and there is no need for a projecting muzzle. The horse, on the other hand, feeds upon grasses that require thorough trituration, and needs the magazine of powerful cheek teeth, which are worn down rapidly and must be renewed as they wear, else the life of the animal would be but a short one. It must use the front teeth for seizing and cropping the grass, and their advanced position and clipping edges are adapted to that purpose. The intelligence of the horse is highly developed along certain lines necessary to his mode of life. His place- and road-memory are remarkable, for in nature he must daily travel long distances to obtain water, food, and security from attack. His eyesight is keen, his sense of smell far more developed than in man; but in reasoning powers and the higher faculties he does not approach the human standard.

Horse and man are sharply contrasted types among the higher vertebrates in structure and adaptation. Most other mammals are more or less intermediate,—but each specializes in various ways and in varying degree in adaptation to its particular mode of life. These specializations are in general most clearly seen in the structure of feet and teeth, which, as Professor Osborn has remarked, are the organs through which the animal comes most directly in contact with its environment. The correspondence between structure and habits in all animals is apparent in innumerable details. Whether the structure is adapted to the habits or, as the palæontologists believe, that there was a gradual coadaptation of both from Primitive common ancestry to the various specializations, whether all structures are in some way useful or advantageous to the animal—these and many other interesting problems belong to the theoretical side of evolution. It is with the facts that we are here concerned.

The horse family stands wide apart from any other group of living animals. The ruminants, which resemble them most in form and habits, differ greatly in the details of their construction. Cattle have long crowned teeth and long slender feet, walking upon the tips of the toes like horses. But the pattern of the grinding teeth is fundamentally different, and the foot is composed of two digits conjoined instead of a single digit as in the horse; and throughout the structure of all ruminants runs a series of superficial resemblance to the horse based upon underlying differences. On the other hand, the tapir and the rhinoceros, superficially very different from the horse, show an underlying resemblance which long ago caused comparative anatomists to unite them into a single order of the Mammalia.

The palæontologist has since shown that these resemblances are due to relationship, that all three are descended from a common stock that existed about the beginning of the Tertiary period and have gradually diverged each in adaptation to its special mode of life. The record of the evolution of the

horse, so far as known, is a record of its progressive specialization from that common stock. That stock was already distinct from the stock that gave rise to the ruminants, pigs, and hippopotami, from the stock that gave rise to the various kinds of Carnivora, and from the ancestral stock of lemurs, monkeys, apes, and men, as well as from a number of other primitive stocks of less interest. Could we follow these stocks further back in time, for another geologic period or so, we should doubtless find that they in turn are derived from a more ancient common stock. But the records to prove this have not yet been unearthed; it remains a matter, not indeed of doubt, but of theory and inference rather than of fact and record.

The present distribution of the horse family, aside from domestic horses, is limited to Africa and central Asia. In the latest geological formations, however, of the Pleistocene epoch, we find fossil remains of various species of horse in all parts of Europe, Asia, and Africa, North and South America. These species are all closely related to the existing horses, one-toed, and with teeth entirely similar to the modern species.

In the next preceding epoch, the Pliocene, we find fossil horses both in the Old World and the New, and some of them in the later part of the Pliocene of Europe are also closely related to the modern horse and are placed in the same genus, *Equus*. In the Lower Pliocene we find three or more genera all evidently related to the horse but of smaller size, with the side toes less reduced, completely formed in some species. In the Miocene there are numerous species, all of them with the side toes complete but small and slender, seldom reaching the ground. They average about the size of a donkey, and their teeth are shorter crowned than in the later horses. In the Oligocene the horses are still smaller, averaging about the size of a sheep, the side toes are less reduced so that they reach the ground and help support the animal, and the teeth are comparatively short crowned with simpler pattern. In the Eocene the horses are still smaller, averaging about the size of a terrier dog, their side toes are quite large, and in the forefoot there is a fourth digit, so that these are known as "four-toed horses." The teeth are still shorter crowned and simpler in pattern.

These are merely the outstanding stages in a long succession of intermediate gradations that connect the modern horse with the little four-toed *Eohippus* of the Lower Eocene. Each gradation is found in its appropriate geological stage, and not earlier or later. The changes and gradations are seen just as clearly in every bone of the skeleton as in the feet and teeth, and the gradual evolution of the race is thus shown by direct and overwhelming evidence. You may indeed, if you choose, declare that each successive gradation was independently created. Direct proof on that point is not at hand; the genetic continuity rests upon inferential evidence. But that the race as such evolved gradually, little by little, through the millions of years of the Tertiary period, is a matter of plain fact and record.

It is equally a matter of record that the now diverse types of tapirs and rhinoceroses evolved gradually from a common ancestral stock with the horses; and that all the records of other races of mammals show them converging backward in time toward a common stock. The *Eohippus* is by no means as different from man as is the modern horse and he is far closer in every detail of his construction to the Eocene representatives of the group to which man belongs (the Primates) than he is to man. All other races of animals display the same convergence toward a common ancestry in every detail of the teeth and feet and skeleton.

The evolution thus shown as a fact of record in certain portions of the history of various races which have been preserved to us in the history of life, appears to be a sure inference as applied to the whole, supported as it is by the community of fundamental structure that prevails through the whole living world, by the obvious adaptation of each race to some particular habit of life, by the proof that natural selection can and must operate to bring about changes in the structure of the race in adaptation to its habits. If we recognize that the records, where they are preserved, show evolution to be a fact, we cannot logically refuse to admit it in the undiscovered portions of the record, upon the force of the immense amount of inferential evidence in its favor, and, in conclusion, because it is the only real explanation of life, the only one that rests upon natural law.

A SCIENTIFIC RECORD FROM THE NEW YORK ZOÖLOGICAL PARK

An instance of phenomenally rapid growth of the true bone of vertebrate animals

SHEDDING AND RENEWAL OF THE ANTLERS OF AMERICAN ELK OR WAPITI SHOWN IN A DEVELOPMENTAL SERIES OF REMARKABLE PHOTOGRAPHS NOT PREVIOUSLY REPRODUCED, BY MR. ELMER SANBORN, PHOTOGRAPHER FOR THE NEW YORK ZOÖLOGICAL SOCIETY (MR. SANBORN HAS DEPICTED THIS GROWTH ALSO IN A SERIES OF MOTION PICTURES)

SEMIDOMESTICATION IN THE NEW YORK ZOÖLOGICAL PARK

American elk antlers consist of two branching round and solid outgrowths of true bone. They are shed each year and their immediate renewal is a phenomenon of astonishing rapidity of bone growth.

Shed antlers are often found in elk territory. Theodore Roosevelt called his ranch on the Little Missouri "The Elkhorn" because shed antlers were numerous on the ground both in the surrounding bottoms and among the hills, sometimes many score in a small area indicating where had been a great winter gathering place for elk

AMERICAN ELK ANTLERS ARE SHED

And there is revealed the top of the pedicel or bony prominence from the skull on which they grew

The perfected antler is dead bone and has no blood supply except at the base where it is attached to the pedicel. The blood in the vessels which penetrate this circular stratum between the living bone of the pedicel and the dead bone of the external antler, gradually, through a few weeks' time, by an absorbent action, takes out the mineral elements and creates an irregular layer of bone so porous that the strength of the whole antler is undermined. Thus the heavy, bony outgrowth finally falls away because of its own weight or is knocked off by some light blow against tree or fence.

Immediately the membrane or periosteum which covers the sides of the pedicel grows up to cover the top where the antler has broken away; also a thin, dark skin, bearing a short fur, outside of the periosteum grows upward to cover the exposed top of the pedicel.

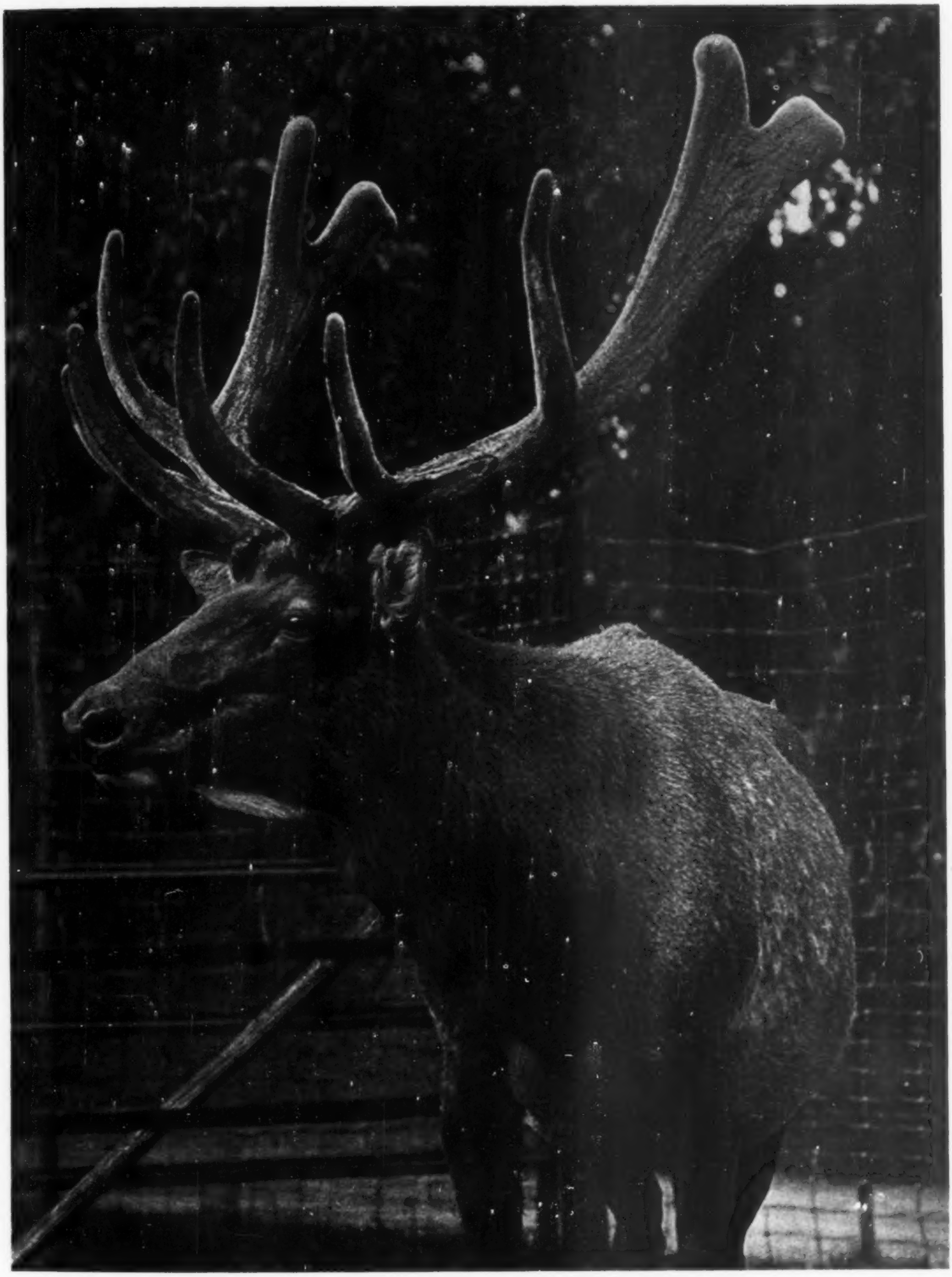
It is only in the semidomestication of the zoölogical park or private preserve that the actual dropping of the antlers and the rapid new growth which follows can be observed in detail

AND THEY ARE RENEWED

Stages in the progress of a growth which requires less than six months for the development of the antlers to the full-grown condition again

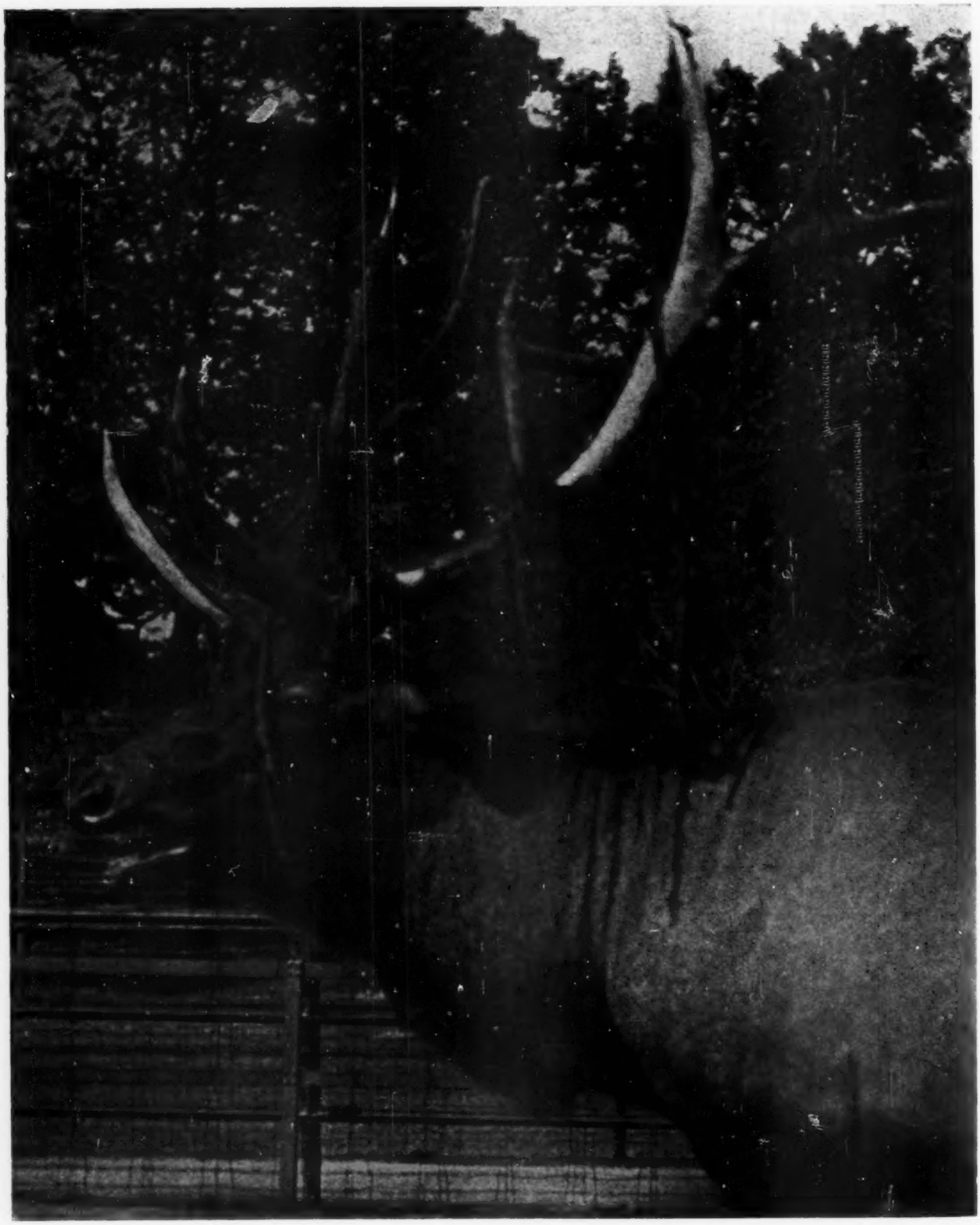
A CIRCLE OF VELVET HORNS

After the periosteum covering the sides of the pedicel, and the skin with its fine fur or "velvet" over that, have extended to cover the top of the skull prominence, the period of remarkable growth sets in. The periosteum is filled with arteries, also a great artery comes up through the core of the pedicel, and these carry so rich a supply of nourishment that the outline of the new antler soon rises into being. Other arteries from the periosteum penetrate into the substance of the new growth at the point of union of the antler with the pedicel. Almost at once the growth shows division into two parts: the posterior, the beam which is to make the elongated axis, and the anterior, the "brow tine"; also immediately the beam divides into two (see photograph on preceding page). The new growth hardens and stiffens through a deposit of bony substance from the blood, and by a still greater and greater deposit, changes from a very porous condition to that of firm and solid bone. The periosteum carries also a rich nerve supply, so that the soft, growing tips of the antlers are highly sensitive and are instinctively protected by the elk from any contact. At the stage of development presented above three tines have been formed and the backward-projecting beam is continuing its growth



APPROACHING COMPLETION BUT STILL "IN THE VELVET"

From the earliest growth to the perfected state the antler, with its artery-filled periosteum, is covered by the protective velvet. In the stage presented here, three tines have been thrown off and the beam has broadened, flattened, and divided for the fourth forward-curving tine. It is not surprising that such antlers, with their astonishing growth, branched structure, and "mossy" appearance, should have been described by very early naturalists (Buffon for instance) as "vegetable products" growing like shrubs on the animal's head



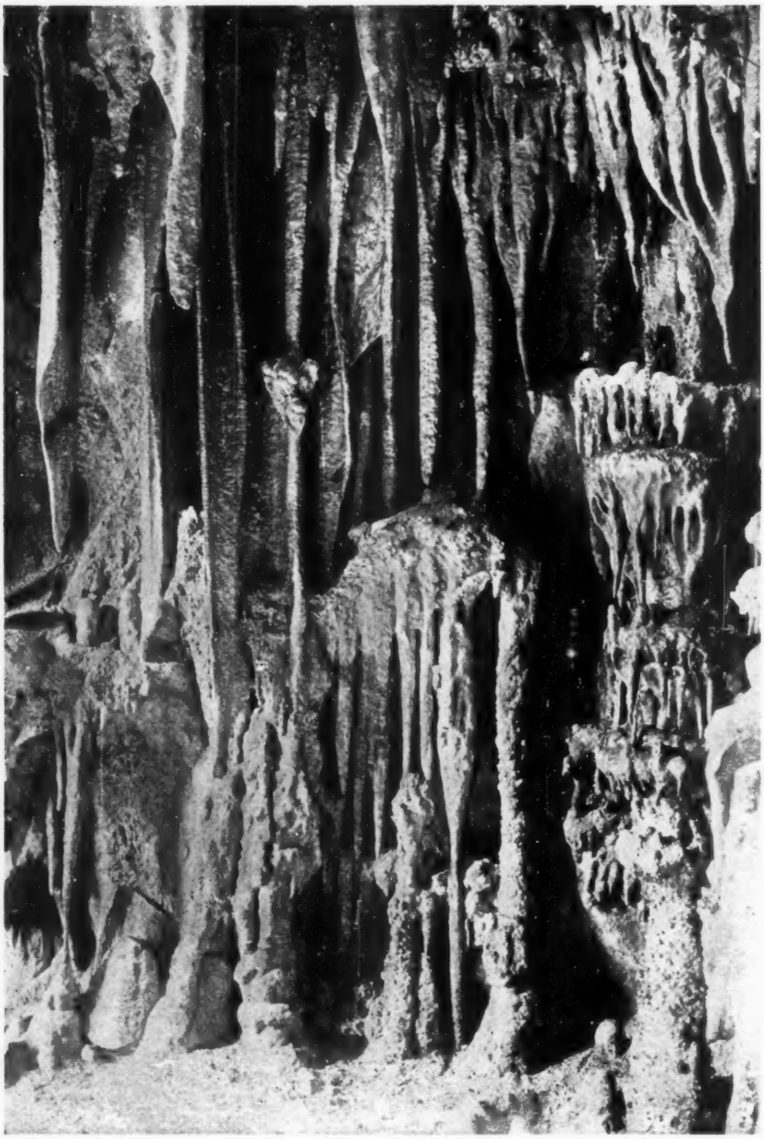
THE VELVET SHREDS AWAY

And the antlers of hard white bone are revealed

Finally the growth is completed. The veins in the interior of the bone which carried back the blood flow from the arteries of the outside velvet, cease to function. The nervous irritation to the animal is considerable until these arteries likewise stop their work. The process is hastened by the elk, which rubs the antlers against fence, tree, or other near object, so that the torn velvet hangs in shreds and wholly drops away, disclosing the white bone

PERFECTED ANTLERS OF AMERICAN ELK

It is said that our American elk have vanished from fully nine-tenths of the country over which they ranged a little more than a century ago—next to the buffalo the most conspicuous instance of game extermination in America. The species has not been known for 150 years in the northern part of its former range, where this range overlapped that of the moose. The last record of elk-killing in Pennsylvania was in 1869; in Illinois the last individuals were seen about 1820; between the Mississippi and the Rocky Mountains, where the Lewis and Clark Expedition found prosperous herds, they were killed out before the early eighties. The final stand of the species is in certain restricted areas of the Rockies. When driven by starvation from this stand, they have no place to flee to—as instanced lately in the slaughter when they tried to seek refuge in Montana. The naturalist in charge at Yellowstone National Park states that the number in the herds that come to the summer feeding grounds, heretofore placed at 45,000, must be corrected to 25,000



A CORNER IN WEYER'S CAVE, VIRGINIA

A portion of the reproduction in the American Museum of one of the grottoes in Weyer's Cave, of the Shenandoah Valley

The fantastic adornment of stalactites abounding in such limestone caverns is shown. As the water, heavy with dissolved bicarbonate of lime, seeps through the roof and falls in drops from the ceiling, it loses some of its carbonic acid by evaporation, causing the precipitation of the excess of carbonate. This precipitate accumulates slowly, forming tubular stalactites or, when the water drips to the floor, conical solid stalagmites. Some of the giant stalactites of Mammoth and Wyandotte caves must be at least one hundred thousand years old.

The material for the American Museum exhibit, presented by the "Grottoes of the Shenandoah Company," was collected from the cave by Messrs. W. B. Peters and P. B. Hill, of the museum preparation department, during 1913 and 1914, and has been installed by Mr. Peters under the direction of Dr. E. O. Hovey

Weyer's Cave Exhibit in the American Museum

WEYER'S Cave, Virginia, lies on the edge of the town of Grottoes in the Shenandoah Valley, and has long been famous for the variety and beauty of its dripstone formations, for the grandeur of some of its halls, and for the daintiness of its nooks and corners. Many such caves, though few so beautiful, are to be found in Virginia, Tennessee, Kentucky, Indiana, and other regions of heavily bedded limestone. A reproduction of a nook in Weyer's Cave has been installed in the hall of geology of the American Museum, with material taken with great difficulty from a chamber seventy-five feet above the floor of the cave. This cave may be considered a typical example of a limestone cavern in a region of abundant annual rainfall. Surface water, acidulated by carbon dioxide from the atmosphere and other acids from the ground, works its way into and along jointing planes and fissures in the limestone and forms larger passages, tunnels, halls, and chambers by solution, "levels" of which, in the miner's use of the word, are established along and above the occasional insoluble and nearly impervious layers of shale which are interbedded with the limestone. Often these open passageways and rooms attain larger dimensions. The "Hall of Statuary" in Weyer's Cave is three hundred feet long, thirty feet wide, and sixty feet high. "Rothrock's Cathedral" in Wyandotte Cave, Indiana, is a circular room three hundred feet in diameter and 135 feet high to the middle of its dome-shaped ceiling. The halls and connecting passages of Mammoth Cave, Kentucky, have been explored for more than two hundred miles of their ramifications on different levels.

With a change in local admission of water to a cave the process of filling the openings with dripstone begins. Dripstone is the name given to both stalactites and stalagmites. A stalactite starts as a paper-thin ring, perhaps a quarter of an inch in diameter, deposited from a drop of water on the ceiling. The drop is pushed off by a new drop behind it and falls to the floor. The new drop adds its paper-thin ring to the first and falls to the floor in its turn. This slow process goes on forming an open tube depending from the ceiling. Sometimes these pipestem tubes are long; one of them exhibited in the J. L. Mohler collection in a case near our grotto at the American Museum is more than a yard in length. Usually, however, the initial tube becomes clogged with crystalline calcite after a few inches of growth in its simple form. The water then flows over the exterior of the tube, depositing its excess load of mineral as a thin layer, which gradually changes the tube into a sharp or blunt cone, hanging point downward. Still there is a drop of water at the apex of the cone, which keeps on forming a tube for the center of the stalactite. A polished cross section shows the concentric rings and layers produced by this process. When the drop of water from the point of a stalactite falls to the floor, it flattens out and deposits only a thin layer of lime carbonate. The next drop adds its quota, and thus is piled up a cone (stalagmite) which usually is much more blunt than the corresponding stalactite, often being rounded or saucer-shaped at its apex. It has no tube, either open or filled, in its center.

This is the simplest description of the process; the conditions of local action produce endless changes in form of deposition, and the wealth and variety of these dripstone formations in some chambers are well illustrated in the American Museum exhibit. When the dripping water carries pure lime carbonate in solution, the resulting dripstone is colorless or white, but often the stalactites and stalagmites are reddish or brownish in color or are banded with these colors, which are due to the presence of minute quantities of dissolved iron oxide. Or, again, clay is deposited over the dripstone during the passage of excessive amounts of water. In some mining regions other colors result from the presence of salts of copper or other metals.

Weyer's Cave, so the story goes, was discovered in 1806 by Bernard Weyer when he was hunting a groundhog which had taken refuge in a fissure in the limestone. Mr. Weyer's pick and shovel opened the way into a cavern which later became one of the famous sights of the Old Dominion and has always been a favorite resort, although partly eclipsed in popular esteem of late years by Luray Cave, forty miles northward in the same valley, which was discovered in 1878.—EDMUND OTIS HOVEY, Curator of Geology and Invertebrate Palæontology, American Museum of Natural History.

A Botanical Excursion to the Big Cypress

By JOHN KUNKEL SMALL

Head Curator of the Museums and Herbarium of the New York Botanical Garden

THE most extensive physiographic trinity or the largest prairie-marsh-swamp region, and at the same time the least known area in the eastern United States, is in southern Florida. The "Big Cypress," or the Big Cypress Swamp, lies south of the Caloosahatchee River between the Everglades and the Gulf of Mexico. The greater part of our population is ignorant even of this geographic designation. To the few who have seen it printed on maps the name signifies nothing, or conveys but a vague idea. Only a score or two of surveyors, hunters, and prospectors, out of the hundred million inhabitants of the United States, have any definite knowledge of its physical geography.

The second week of May, 1917, we were on the very edge of the Big Cypress when we navigated Lake Hicpochee during a cruise to Lake Okeechobee. The day we returned from that cruise, which was described in former papers,[1] an opportunity to explore some of the mysteries of the Big Cypress unexpectedly presented itself. Mr. W. Stanley Hanson, a bird inspector with the United States Biological Survey, and a naturalist well acquainted with the Big Cypress, had come to Miami across country from Fort Myers, whence he was about to retrace his course. The opportunity to accompany him on a trip through largely unknown territory was a temptation too great to be resisted. Consequently, we prepared a Ford for a week's run, and the next day set out for Fort Myers. Miami and Fort Myers are about 120 miles distant from each other, in a direct line, but the intervening area could have been conveniently, or at least expeditiously, traveled only in an aëroplane. The shortest course possible for us followed a curve more than 250 miles in length.

In order to bring us to our most distant objective which lay across the Everglades only about sixty miles from Miami, we had to make a detour around the Everglades and Lake Okeechobee at their head. The facilities for making an examination of the country and a collection of specimens of its vegetation were generously furnished by Mr. Charles Deering, of Miami.

The first stage of our course lay along the eastern coast of Florida between Miami and Fort Pierce. Miami, Fort Pierce, and Fort Myers are about equidistant one from the other, or, straight lines connecting the three places would form an equilateral triangle. The territory included in the triangle, made up mostly of everglades, prairies, cypress swamp, and pineland, together with Lake Okeechobee situated near one side of the triangle, was essentially uninhabited, except for the scattered settlements in the Caloosahatchee River region. Between Miami and Fort Pierce pinelands and sand dunes (scrub[2]) predominate; between Fort Pierce and Fort Myers are pinelands and prairies; while between Fort Myers and Miami lie prairies, cypress swamps, and the Everglades.

Mr. Hanson preceded us to West Palm Beach, where we overtook him. It was late in the evening when we reached Stuart, where we had to spend the night because of a high wind which made the ferryman hesitate to carry us across the Saint Lucie River. An early start the next morning brought us to Fort Pierce in time for breakfast. Thence we started on the second leg of the triangle, proceeding in a southwesterly direction.

Between Miami and Fort Pierce our course took us through not fewer than forty towns.[3] After leaving Fort Pierce only four settlements were encountered, two established settlements and two embryonic colonies.

After Fort Pierce disappeared from view we sped westward through pinelands and across the Halpatiokee Swamp, where countless turtles and snakes basked in the sun about the water pools that lined the road.

[1] *Journal of the New York Botanical Garden*, Vol. XIX, 1918, pp. 279–90. THE AMERICAN MUSEUM JOURNAL, Vol. XVIII, 1918, pp. 684–700.

[2] These are quiescent inland dunes of snow-white sand.

[3] These lie outside of the triangle of uninhabited territory referred to in a previous paragraph.

A TRANQUIL JUNGLE STREAM ON THE INDIAN PRAIRIE

Fisheating Creek, or, in less commonplace parlance, "Thlathtopopkahatchee," is still little known, because it runs through nearly uninhabited country. It rises as a drain for a greatly elongated (twenty-five mile) slough which lies near or forms the western boundary of the southern extension of the lake region of Florida. The creek is almost equal in length to the slough it drains. It meanders through pine woods and through prairies, ultimately reaching Lake Okeechobee. Its banks are often hammock clad. Live oaks, sweet bays, and red maples predominate on the shores, and in some places conifers—pine or cypress—or cabbage trees replace the hammock. Occasionally long stretches of water are completely concealed by floating carpets of water hyacinth, and others, clear of all aquatic plants, sharply mirror the bordering vegetation

After crossing the swamp another stretch of sandy pine woods was traversed with difficulty, as the combined power of the engine and the pushing ability of the occupants of the car were necessary to get through the twelve miles of loose sand. Finally the Onoshohatchee River and the first habitation in about forty miles came into view. We soon reached Okeechobee City—then a settlement of several scores of houses. In the fall of 1913 when we went up the Onoshohatchee River from Lake Okeechobee this place had been indicated on the map and staked out by the surveyors, but had not yet been colonized.

At this point we again left civilization behind. From Okeechobee City to Fisheating Creek the country was devoid even of roads, and we took to an old trail dating back perhaps to a period before the Seminole wars. By degrees Okeechobee City disappeared as we hurried around the curves, not to say coils, in the trail, and after passing some miles of pinelands we suddenly came into the bottoms or prairies of the Kissimmee River. These bottom lands are like immense lawns, perfectly level, carpeted with a turf of various grasses, and often extending as far as the eye can see. There were thousands of semiwild cattle grazing on the broad green prairies.

All had gone well thus far, but at the Kissimmee River a series of apparently predestinated troubles began. The trails on either side of the river were connected by a ferry which consisted of a flatboat large enough to hold a car, and a small motor boat of barely sufficient capacity to drag the flatboat around the bends and over the sand bars in the river. In order to cross the river, which there is less than a hundred feet wide, it was necessary to go about a half mile down stream because of the erosion of the banks. Once in the stream the current of the river—say, three miles an hour—carried the ferryboat along at a greater speed than the motor boat could maintain. Time and again the ferryboat would bump into the river banks, first on one side, then on the other, and would, in turn, bump against the stern of the little motor boat and knock off the rudder. Even after the ferryboat drifted out of sight, we who were left behind for the second trip could hear the ferryman nailing the rudder on his disabled boat.

We lost several hours of valuable daylight while waiting for the ferryman to replace dead batteries with live ones. As the short twilight deepened we ran up a slight incline through a strip of pine woods, making all haste compatible with the innumerable curves in the trail and the proximity of pine stumps, and found ourselves on the great Indian Prairie. This comprises a large part of an immense region lying west of Lake Okeechobee, north of the Caloosahatchee River, and east of Peace River. The prairie is high and dry all the year round and is uninterrupted, except by a single stream, Fisheating Creek, one of the larger feeders of Okeechobee. Up to a short time ago it was practically uninhabited, except by wandering Indians. At the present time a half dozen or more "—ports," "—dales," "—monts," "—burgs," and even "—Cities" have been put on the map, and a railroad bisects the region,—so, farewell to its natural features.

In order to save time, we decided to cross the prairie that night, and we certainly had a weird ride. The trail at times was distinct, but at other times almost blind. Although the prairie was a dead level, the optical illusion created in the darkness was that of running down hill and jumping off the earth. We had some obstructions to progress in the form of forks in the trail which would, we knew, either come together farther on or diverge indefinitely and thus lead to some other part of the state. At each fork, the four in our party would hold a council, and in each instance consult the stars. The stars always put us on the right trail, and toward midnight, after passing several half-discerned Indian camps, we saw a few faint lights of human habitation appear, and finally we reached the recently established colony of Palmdale on Fisheating Creek, or, in Seminole, "Thlathtopopkahatchee."

We did not hesitate to disturb the peaceful slumbers of the inhabitants, who were as glad to see us as we were to see them, which fact they showed in a substantial manner by arising from their slumbers and preparing a midnight meal. After a few hours' rest we made an early start for Labelle, which is an old settlement situated at about the head of natural navigation on the Caloosahatchee River.

The Indian Prairie extends nearly or quite

to the Caloosahatchee. Unfortunately, a road had been laid out to connect Palmdale with Labelle. It is well we decided to stop at Palmdale until daylight, for although we could travel the almost trackless prairie in the dark with ease, we could barely traverse this new road in broad daylight. The deep sand had become very loose, and it took more than the engine to get the cars over a good many miles of the road.

Just south of Palmdale we crossed Fisheating Creek, which is an exceedingly picturesque stream meandering through the almost uninhabited prairie, between banks either exposed to the sun, or clothed with shrubs and bright-colored asters or hammocks of oaks, ash, and maple, which in some places give way to groves of palmettos that often lean far over the water's edge. After leaving the hammocks which border the creek we drove out on the prairie again, and few trees came into view for a distance of about eighteen miles, until the hammocks bordering the Caloosahatchee appeared.

Perhaps the most interesting creature on these prairies was the burrowing owl. This bird had honeycombed the prairie in many places with its burrows. These tunnels, often six to eight feet long, are about a foot beneath the surface of the sand. At one end is an opening approximately six inches in diameter, while at the other end is a nest. The old owls were so tame that one could almost pick them up, and often they would sit perfectly quiet while the automobiles passed them at a distance of not more than two feet.[1]

On this same prairie many interesting plants were observed and collected. Milkweeds were represented by species of *Asclepias* and *Asclepiodora*, while more conspicuous was the purple water willow (*Dianthera crassifolia*). Low milkworts (*Polygalæ*) with white and yellow flowers were prominent in the landscape, and clumps of the native beardtongue (*Pentstemon multiflorus*) towered above all the other herbaceous plants. There a white-flowered heliotrope replaced the common yellow-flowered heliotrope of the region lying east of the Okeechobee basin and the Everglades.

After contending with the sand for several hours we reached the Caloosahatchee River and came to the town of Labelle, where we did not delay, but went directly up the Caloosahatchee several miles to Fort Thompson. There we found a number of magnificent live oaks around the old barracks which date from the period of the Seminole wars. After making a number of photographs in that region we returned to Labelle and at once started down the south bank of the Caloosahatchee River for Fort Myers.

We now left the prairies behind and entered the flatwoods, where the arboreous vegetation is made up almost entirely of pine trees. Peninsular Florida, especially the southern part, lacks what is ordinarily understood as altitudes, in fact, most of it is decidedly flat. It might well be called a large sand bar. Notwithstanding this disadvantage, it reveals an astonishing number of surprises in the matter of diversity. The Big Cypress is one of the larger surprises. Its area is about half that of the

[1] Out of curiosity we decided to dig into one of the burrows. Starting at the opening, we began by lifting the sand out very carefully. Of a sudden we were startled by the rattle of a rattlesnake. After proceeding a few inches farther we heard two rattlesnakes; before going much farther into the burrow a third rattlesnake began to rattle. The digging became more exciting as we worked farther in and as the snakes rattled more loudly. When we neared the end of the burrow we cautioned one another to be careful not to get our hands too close to the snakes.

This seemed to be an excellent opportunity to get good photographs of living rattlesnakes. Consequently the camera was set up and everything prepared for the opening of the end of the burrow. As there was no woody growth on the prairie the question of getting sticks with which to fight the snakes arose. After considerable search several surveyor's stakes were found, and with these we prepared nooses for capturing the serpents alive. With extreme caution we approached the end of the burrow; the snakes began to rattle more viciously. Finally the sand was removed from the top of the end of the burrow, and to our surprise we found four young owls, three large and one small, but—no snakes!

It was the three larger owls that were making the noise of a rattlesnake, and imitating it so well that all of us who had had personal experience with rattlesnakes were deceived. We decided that this experience proved that the stories we used to hear of owls, prairie dogs, and rattlesnakes living peacefully together in the same burrow were fantastic. Of course, a rattlesnake might enter an owl's burrow, either to seek shelter or food; but it is a difficult matter for any one well acquainted with the habits of rattlesnakes to believe that a husky rattler would be considerate and restrain his appetite, with such a tempting morsel as a young owl or young prairie dog lying about in his den. (For further notes on this subject see: *The American Naturalist*, Vol. XLI, pp. 725–726; Vol. XLIII, pp. 754–55; *Birds of the World*, pp. 536–37.) After photographing owls instead of rattlesnakes, we replaced them in their nest and rebuilt their burrow, as well as we could, by making a roof of brush over which we replaced the sand.

Palms and pine trees are often a favorite refuge for wild turkey and deer. A flock of turkeys took refuge in this particular grove just as we suddenly rounded a sharp curve in the trail. In the Big Cypress there may be prairies so extensive that woody vegetation can be seen merely as a dark line along the distant horizon, or again we may see at one time associations of palms and pines, pure pine woods, solid broad-leaved hammocks, cypress heads, and combinations of cypress head and hammock

Everglades, and although it abuts directly on the western side of them, it has but little in common with them. Instead of being a vast prairie-marsh like the Everglades, the Big Cypress exhibits a variety of conditions and plant associations. There are pinelands, prairie, sloughs, cypress heads, hardwood hammocks, palmetto hammocks, and lakes.

Early in the afternoon we were prepared to strike into the wilderness. After leaving Fort Myers, roads disappeared and we took to mere trails through the pine woods in a southeasterly direction. As we proceeded, strange plants and strange birds began to appear. White terrestrial orchids (*Gymnadeniopsis nivea*) and single-flowered spider lilies (*Hymenocallis humilis*) dotted the dry prairies, while uliginous creepers with various colored flowers formed encircling mats about all the shallow ponds. Ponds and pools were the favorite feeding places for the wood ibis, the white ibis, cranes, and herons. The hammocks hid many flocks of wild turkeys in their depths.

For some distance outside of Fort Myers we traveled through unbroken pine woods. As we went on, the pine trees became more scattered and areas of prairie came into view. Farther on, the prairie began to increase and the pines appeared only here and there as isolated colonies. A little farther on cypress trees appeared, and we were really in the Big Cypress. Here, too, the cabbage palm was much in evidence, and in some places it formed hammocks of almost pure growth. As we proceeded, the prairies grew larger and the cypress grew less, until there was open prairie in all directions almost as far as the eye could see. Then the hammocks clothing the Okaloacoochee Slough appeared in the distance as a mere line on the horizon. It is said that the Seminole word "Okaloacoochee" signifies "boggy-slough." Consequently the usually associated word "slough" is really superfluous.

As we approached the slough we observed immense flocks of ibis collecting at their rookery for the night. The confused sounds they made as they flew over the tops of the tall trees could be heard for a distance of a mile. The sight of the great flocks of ibis and the racket of their croaks or squawks as they collected in their rookery we shall long remember.

We drove into a small hammock within half a mile of the slough and prepared to camp there for the night. Many interesting plants were collected on the prairies near the slough before darkness drove us back to camp. Indian plantains (*Mesadenia*), foxgloves (*Agalinis*), and heliotropes (*Heliotropium*) grew nearly everywhere. Fully as interesting as the native plants was the climbing black-eyed Susan (*Thunbergia alata*), which we found extensively naturalized on the prairie near the Okaloacoochee. The plants now growing there may be the descendants of specimens introduced and cultivated in gardens the Seminoles maintained there fully a century ago.

The following morning we broke camp about daybreak and proceeded to cross the slough. We parked our cars in its midst on the very spot where, it is said, more than sixty years ago Lieutenant Harsuff's company of engineers had their sanguinary clash with Chief Billy Bowlegs—after they had destroyed the old chief's garden just to "see old Billy cut up."

The larger trees of this hammock consist of the bald cypress or river cypress (*Taxodium distichum*). It was a favorite spot for the Indians to obtain logs for making their dugout canoes. In the rainy season there is commonly about six feet of water in the slough. After the rainy season the water table is naturally lowered by seepage. The waters, evidently, find their way directly into the Everglade basin, and directly or indirectly into the Gulf of Mexico. In the dry season most of the slough can be traversed on foot. It was the custom of the Indians to go to the slough in the dry season, cut down the trees they selected for making the canoes, and then wait for the wet season and high water to float the logs out toward the western coast.

We went down the slough afoot just as the thousands of birds in the rookery were awakening. The birds mostly represented several species of ibis, and were present by the hundreds and thousands on the large cypress trees. In fact, they were so crowded on some of the giant cypresses that they were continually falling off for want of sufficient room to stand. As a consequence of not having been much disturbed by man, they were so tame that one could walk

In the Okaloacoochee Slough dead trees as well as living serve as part of the ibis rookery, for the birds are so numerous that any available space is used. Their nests are rude cradles of sticks in the trees or on ledges of rock. During the day the birds leave the rookery, traveling in more or less definite groups or companies. This photograph was taken in the morning, after the greater number of the birds had departed

A NATURAL AMBUSCADE

From such beautiful coverts—perhaps from this very spot—commands of the United States Army fought the Indians during the Seminole wars. A riotous growth of shrubs whose stems are intertwined with woody vines form an almost impenetrable thicket extending back to a wood of river cypress in the lower part of the slough. The hammock floor is a mass of ferns and small herbs; Boston and sword ferns in particular are prevalent. There are at least fifty other kinds of ferns—many of them epiphytic—which display the greatest possible variety in structure and contour

toward them, set up a camera, and photograph them at short range.

There was water in the lower parts of the slough, but none was visible, for the surface was completely covered with a soft carpet of various small aquatics. These were distributed in patches of beautiful shades of green. In the higher parts of the slough ferns and flowering plants grew in about equal profusion and remarkable luxuriance. The growth reminded me of that in the hammocks of the eastern shore of Lake Okeechobee.[1] The large, straplike leaves of the spider lily and the paddle-like leaves of the golden club or bog torches (*Orontium*) were very conspicuous. The leaves of the golden club here at its most southern known station were fully three feet long, while the fruiting spadices lying around on the ground were thrice the size of any that I have ever observed at the north. The lizard's-tail (*Saururus*) was also there in great abundance.

Thus these typically northern plants, the lizard's-tail and golden club, are there intimately associated with such typically southern plants as the water hyacinth and the water lettuce. Other southern elements represented are the Boston fern (*Nephrolepis exaltata*) and the wild coffee (*Psychotria undata*).

After making a collection of all the plants observed and photographing the more interesting views, we returned to our cars, crossed the slough, and set out over the prairie in the direction of Rocky Lake, which lies in an uncharted spot in the Big Cypress between the Okaloacoochee Slough and the Everglades. As we proceeded, palmetto hammocks, hardwood hammocks, and cypress heads became more numerous on the prairie. At last we came to the hammock surrounding Rocky Lake, which is known to the Seminoles as Okee-hy-yot-lochee, a word said to mean "wide-open-water," where we camped for lunch, and made collections of the plants. This lake is contained in a rock basin several acres in extent. It is said that it is fully seventy-five feet deep, and abounds in fish and alligators. Of course, it would be somewhat of an exaggeration to say that one could walk across the lake on the alligators' backs; but they were more numerous than I have ever seen them elsewhere.

After lunch we set out for the ruins of an Indian mission[2] which some years before had been established near the site of the one-time Fort Shackleford, and then abandoned. After leaving Rocky Lake the trail wound in and out between hammocks and cypress heads until finally more open prairie was reached.

When we arrived at the Seminole mission we were now not more than four miles from the western edge of the Everglades. A unique specimen of the cabbage tree was observed—a five-fingered object, with five branches of about equal length arising from the trunk, just above the surface of the ground and all in one plane. Probably nowhere is this duplicated. Many interesting plants were found in the vicinity, especially several loosestrifes (*Lythrum*), and a false indigo (*Amorpha*) which is apparently different from any known species.

[1] See *Journal of the New York Botanical Garden*, Vol. XV, pp. 69–79; Vol. XIX, pp. 279–290. The AMERICAN MUSEUM JOURNAL, Vol. XVIII, pp. 684–700.

[2] The old Seminole mission thirty-five miles beyond Immokalee was established about 1910–11 through the instrumentality of William Crane Gray, then Bishop of southern Florida, for the Protestant Episcopal Church, the work being undertaken by Dr. William J. Godden, of Greenwich, England, who happened then to be touring the United States. Dr. Godden, a man of high connections and attainments, soon won the love of both red and white men. Originally, he started a small hospital and social center for the Seminoles at a point about seventy miles back from Fort Myers, near the historic site of old Fort Shackleford. He called this first settlement Glade Cross—because of its proximity to the Everglades and the large white cross he mounted against a cabbage palm. But when a couple of red patients died in the hospital no more Seminoles could be induced to come near the place. The mission was thereupon transferred to the lonely outpost called Boat Landing, on the edge of the Everglades, at that time the head of all the canoe trails of the region. It was not long, though, before the partial drainage of the Everglades dried the canoe trails, and Boat Landing ceased to be a port of call, or any port at all. So the doctor once more moved his mission, this time to about the center of the present Seminole Reservation, five or six miles from his former locations, right in the heart of the Big Cypress, where he hoped to establish an experimental farm. He put up a number of buildings—a store, a dispensary, various shelters. He employed the Seminoles to dig a couple of miles of drainage ditches about the place. He himself worked far harder than anyone else—without pay, mostly alone, always devoted, perfectly kind—while his people in England urged him to return to them. He died at the mission, suddenly, presumably of heart failure, in 1914. And now Glade Cross is jungle again; only a few broken canoes mark the site of Boat Landing; and the last site of all, still called "Godden's Mission," is merely a weedy, haunted ruin. The doctor's body was buried at Immokalee, a Seminole word which signifies "My Home."—Perley Poore Sheehan.

YOUNG OWLS AT THE FAR END OF A BURROW IN THE SAND

We sometimes find in the sand of the prairie a hole about six inches in diameter—the entrance to the home of the burrowing owls. Such holes occur in "towns" of from three to twelve or more; some parts of the prairie are so honeycombed with burrows that we marvel how they and the nests in them are preserved from destruction during heavy rains. The nest is built about six or eight feet from the opening of the burrow and commonly is only six or eight inches beneath the surface. The parent owls are rather tame and may be approached within a few feet, but the young birds are vicious in appearance, voice, and manner—at least when disturbed. How could anyone ever have believed that a rattlesnake and such tempting morsels of food as these young owls would be likely to live long in peace within the same burrow

ever have believed that a rattlesnake and such tempting morsels of food as these young owls would be likely to live long in peace within the same burrow

A FLOATING MEADOW OF FLOWERS

The water hyacinth (which completely covers the water in this tributary of the Caloosahatchee) always improves the landscape, and usually is not the impediment to navigation that it has the reputation of being. Moreover, the more or less extensive areas of bright blue flowers set above the deep green leaves are unique in our flora. Live oaks, laurel oaks, and water hickories line the banks of this stream, and the long growths of Florida moss reach from the spreading limbs of the trees to the water

A GIANT TREE OF THE FLORIDA "BIG CYPRESS"

The brilliant green of the river cypress, which largely forests the sloughs, is intensified by contrast with the waving grayish white streamers of Florida moss and the gay pink and white plumage of the nesting ibis. In the widespreading limbs of the giant trees hundreds of the birds roost and when they rise in their powerful flight the sun burnishes their outstretched wings with a metallic sheen that adds a further touch of the picturesque to the landscape. The birds covered the top of this tree when it was photographed, outlining it against the sky, but their colors on the light background failed to impress the photographic plate

NATURE GIVES THEM A FORMAL ARRANGEMENT

Relatively slender and narrow-branched trunks are characteristic of the pond cypress so that it is not adapted to support rookeries. It harbors great quantities of air plants and, although it does not bear a copious growth of Florida moss, several other species of *Tillandsia* cling to its branches,—often through the accumulation of generations the plants form masses out of all proportion to the size of the tree. Pond cypresses are usually evenly spaced as if following an architectural plan, whether they are distant from one another, as here shown, or set so closely together that passage between their trunks is difficult

Wild orange trees, some with sour fruits, others with sweet, occur in the hammocks of the Big Cypress. Of course, some of these are the remnants of trees planted by the Seminoles; but others may be derived from ancestors planted there by the aborigines of that region or by the Spanish adventurers themselves.

The cypress of the region outside of the large sloughs was the pond cypress (*Taxodium ascendens*). The prairies were showy flower gardens. Several species of *Polygala,* several of *Sabbatia,* three or four kinds of terrestrial orchids, and a number of other conspicuous plants, both monocotyledons and dicotyledons, often covered acres in extent. A yellow-flowered bladderwort grew copiously in extensive patches in the dry white sand! Many rare and little-known plants were collected for future study.

Rocky Lake proved to be the lunch station. While in a temporary camp near the shore the writer rescued two animals from living graves. On two different occasions, while going to the lake for a drink of water, he was startled by agonizing cries. In the first instance, a large water moccasin had caught a mocking bird and was attempting to swallow it. In the second instance, another moccasin had caught a frog which he was trying to slip down his throat. In each case the victim went free and, it is to be hoped, survived.

After recrossing the Okaloacoochee Slough, instead of retracing our former course we turned more to the westward and headed for the colony of Immokalee. After passing through stretches of forest and prairie we came in view of the scattered houses of the settlement. This colony, situated about thirty miles in a direct line from Fort Myers, comprises a general store and a few dwelling houses. We reached Fort Myers shortly after sunset, and early the following morning started up the Caloosahatchee River by the same course we had taken several days before. Numerous stops were made along the way for collecting plants and taking photographs. Palmdale, where we took the trail over the great Indian Prairie, was reached early in the afternoon. The herbaceous vegetation and magnificent palmetto hammocks not visible in the dark gave an entirely different impression of the prairie region. Some of the same genera of plants were common to both the Indian Prairie and the Big Cypress but the species were usually different. The Caloosahatchee River is evidently a natural boundary between different floral regions. The most striking feature in the vegetation of this prairie, however, is the cabbage tree. This palm grows in small clumps and also forms hammocks from one to many acres in extent, surpassing in luxuriance any growth of it I had seen previously.

After the usual bumping of banks and sand bars the ferry landed us on the opposite shore of the Kissimmee River whence we at once set out over a trail which seemed to have endless windings, but which finally brought us to Okeechobee City. From there, after a night's rest, we journeyed to Fort Pierce, collecting as we found favorable places in the pine woods and in the swamps, and next day we started on the final stage of our return trip to Miami. The city was reached without further incident, except the passing survey of a large hammock on a high sand dune along Saint Lucie Sound or Lower Indian River, which has already been partly described[1] and which has been designated for thorough exploration.

This preliminary survey deeply impressed upon us the wonderful natural history of that little-known region. Our time was limited and the region was large, but some day, before drainage and other depredations of civilization, not to mention vandalism, have removed the bloom from that still unspoiled garden, we hope to make another and longer visit to the land of the Big Cypress.

[1] *Journal of the New York Botanical Garden,* Vol. XIX, pp. 76-77.

The Gypsy Moth in New Jersey

THE gypsy moth (*Porthetria dispar*) entered America in 1868, and it has been one of the most troublesome of insect pests ever since, but by great effort and the expenditure of millions of dollars it has been confined to the New England States. Now, however, it has invaded New Jersey. This invasion probably started about 1911 through the introduction of blue spruces imported from Holland for the James B. Duke estate at Somerville (about 2300 acres extensively planted to evergreens and ornamental shrubs). At that time there was virtually no government inspection system in force and the pest probably came in at the docks without being noted.

The infested area now covers about one hundred square miles of territory with Somerville as the center. In addition the insect has been located at Deal Beach, South Orange, Paterson, Ridgewood, and Madison, New Jersey, and also at Loretto, Pennsylvania. These infestations owed their origin to trees shipped from the Duke estate. All of the stock that has ever been sent out from this estate is being traced and inspected by federal men.

The New Jersey State Department of Agriculture is planning to ask an immediate appropriation to be used in fighting the pest. The entire northern part of New Jersey with its valuable estates and ornamental plantings is threatened. The insect attacks especially shade and forest trees, although it feeds also on the trees of the orchard. Indeed, the destructive ability of the nocturnal young caterpillars may be judged from the fact that they feed on more than five hundred species of plants. If it were an insect that attacked agricultural crops, each farmer might be able to save his own acreage, but the protection of shade trees and forest areas must rest with state and federal governments.

New England is spending $1,000,000 every year just to hold this insect in check within its boundaries. If the gypsy moth is allowed to spread in New Jersey, it is only a question of time before it will be in New York and neighboring states which have unusually large forest interests. Evergreens, when once their foliage is lost, are killed for all time, and deciduous trees, if defoliated more than two or three years in succession, usually die also.

It will probably require from three to five years before we can say with any degree of certainty that the gypsy-moth pest in New Jersey has been cleaned up. The whole territory will have to be scouted again and again to be sure that nothing has been missed. It is greatly to be hoped that the plague has not found entrance to the forests of Watchung Mountains just outside of Somerville. If it is there, the work will take more time and effort because of the difficulty of spraying trees on the mountainside.—H. B. WEISS, Chief of the Bureau of Statistics and Inspection, New Jersey State Department of Agriculture.

Foreign Insects Newly Come to America[1]

A SMALL member of the Lepidoptera, a pyralid moth (*Pyrausta nubilalis*), has recently found its way to this country from Europe, probably in a shipment of broom corn from Austria-Hungary, and some of our best economic entomologists fear that it may become a very serious pest. It was discovered in 1919 infesting corn in the vicinity of Boston. The insect has only one brood a year in some places, but in others not only do adults appear in May from larvæ that have overwintered in old stalks, but there is another generation in midsummer. The larvæ bore their way into the tassel stalk, causing it to break, or into the main stem, lowering the vitality of the plant, or into the ear, spoiling it for food. *Pyrausta* breeds, also, in a great variety of weeds which makes it more difficult to control.

Another newly introduced pest is the "green Japanese beetle" (*Popillia japonica*) which skeletonizes the leaves of various trees and hardy shrubs. It is a small scarabæid that was discovered in 1916 in Burlington County, New Jersey, but a recent bulletin states that in 1919 it had increased to such an extent that 20,000 beetles could "be col-

[1] For fuller details of these and other insects common in the northeastern United States see the 1921 edition of *Field Book of Insects*. G. P. Putnam's Sons.

lected by hand by one person in a single day." The first beetles probably came in with earth surrounding the roots of some ornamental plant such as iris or azalea.

Among the foreign insects which have entered American ranks, spreading beyond their point of entry, it is pleasant to record one which is not injurious. This is *Calosoma sycophanta,* well named "caterpillar hunter," a European beetle which was introduced near Boston some years ago to help in the control of the brown-tail moth. It is now well represented in the vicinity of New York City.

On the other hand, practically every one of the insects that are seriously injurious to our crops in America are introduced species. I do not recall now a single native insect that is a decided plague. The Hessian fly and the cabbage butterfly, for instance, are both introduced species.

Our native insects have been here a long time and have already spread as far as they are going to. Foreign insects, however, which have just come in will spread until they have reached a distributional limit. That they multiply so rapidly and can spread with such alarming speed is explained in part by the fact that the parasites which preyed upon them in their old homes were not introduced with them. Our economic entomologists are importing these enemies of the foreign insects as the most feasible method of control.—FRANK E. LUTZ, Associate Curator of Insects, American Museum.

A Case in Point to Prove the Value of Prolonged Research

THE facts are being set forth, by Samuel J. Record, professor of forest products and expert on wood identification at Yale University, of a wonderful achievement in lumber drying. Mr. Harry Donald Tiemann, dry kiln specialist of the Government Forest Products Laboratory at Madison, Wisconsin, has revolutionized the industry[1] and he did it at just the psychological moment in the history of lumber drying in the United States. This was when we entered the World War and the demand became immediate for vast amounts of *dry* lumber for the various implements of war. Lumber manufacturers had no quick method for drying oak, hickory, and walnut, the woods especially needed. The customary method often required four or five years—merely to expose the timbers in protected piles. Dry kilns were used only for shingles and other thin specimens or for the softer woods.

Fortunately for the situation, one man in the country had been spending years of research on this very problem, namely, the behavior of wood relative to its moisture content. He had experimented during six years at Yale Forest School, using testing machines and compiling results gained from crushing and breaking wood under all conditions of moisture—green, water-soaked, kiln-dried, air-dried, boiled, and steamed. He had continued his experimental work at the Forest Products Laboratory, of the University of Wisconsin, from 1909 to the opening of the war. Here he had been able to use experimental kilns in which temperature and humidity were under measured control, as well as circulation of air. He finally evolved from his long series of experiments a process by which the drying is accomplished through regulation of the humidity in the kilns—the kilns being especially devised drying chambers of his own invention, but of such character that they can be developed without great difficulty from the manufacturer's ordinary kilns.

There could be no more powerful specific proof of the value of prolonged scientific research and experiment, whether within an industry or under the auspices of the government or in an academic institution. These kilns invented by Mr. Tiemann allowed drying the most refractory kinds of lumber in limited periods of time and with no loss of either strength or elasticity of the wood. Oak for wheel stocks was perfectly seasoned in three months instead of from three to five years; black walnut was dried for army rifles in two months; and aëroplane stock was prepared in one month. It is not easy to estimate or properly appreciate the value to the nation of so vast a service.—THE EDITOR.

[1] I quote from a letter from Professor Record: "What I have attempted to do is to lift the veil of anonymity that shrouds government employment and reveal the great work of an individual. Of course others and the organization have helped in the practical application but the basic fact and theories were worked out through years of concentration on the part of Mr. Tiemann."

Notes

OWING to unavoidable delays in the preparation of NATURAL HISTORY it has been necessary to omit the July-August number, and the present issue for September-October, containing an increased number of pages and illustrations, takes its place.

SIR NORMAN LOCKYER, for fifty years editor of *Nature* and one of the leading astrophysicists of the world, died on August 16. Sir Norman was one of the pioneers in the application of spectroscopy to astronomy. He was the first to observe the solar prominences at times other than during an eclipse, discovering in the course of this study the element helium twenty-seven years before it was isolated on the earth. He was director of the British Solar Physics Observatory from 1885 to 1913. Later he devoted himself to erecting an observatory and station at Sidmouth, where he spent the last years of his life. Not only in pure science but also in public activities was Sir Norman a leading figure in England. He was among the first to impress the British government as to the value of science to the army and navy; he led in the founding of the British Science Guild, which remains as an institution for stimulating the application of science; and it was indirectly owing to his clear presentation of the needs of the nation that the government made large grants to the universities for scientific research.

WORD has recently reached the American Museum of the death in 1916, in the Fayûm, of Richard Markgraf, the veteran collector of Egyptian fossils. Mr. Markgraf was an Austrian by birth and, in his earlier years, a professional musician. While in the prime of life, serious pulmonary trouble made it necessary for him to leave the humidity of Europe and so he moved across the Mediterranean to Egypt, where the wonderful arid climate enabled him to continue life in moderate comfort for twenty years or more. Here he took up natural history collecting as a means of livelihood, and after the discovery by the Egyptian Survey, about the year 1900, of the remarkable ancient mammal fauna in the desert sands along the edge of the Fayûm depression, he directed his efforts to the search for these fossils, working during the cooler months of the year with a small caravan of two or three camels and a native assistant. In this work he was employed principally by Professor Eberhard Fraas, of the Stuttgart Museum, and the extensive collections sent by Markgraf to that institution have since been the subject of elaborate memoirs by German palæontologists. The American Museum's expedition to the Fayûm in 1907, under the leadership of President Henry Fairfield Osborn, was visited in its desert camp by Markgraf, who was at that time unemployed. His services were immediately engaged, and he carried on, with his own equipment, exploration work in that vicinity for several months. After the return of the expedition to America he was employed at intervals over a period of two or three years for short trips into the desert, always with success. As a total result of this work our Fayûm collection has been greatly increased and several of the choicest specimens of the American Museum are credited to him.

THE hundredth anniversary of the birth of Andrew Haskell Green was celebrated on October 6 in New York City. He was at one time president of the Board of Education and comptroller of the city, and was closely associated in the last named capacity with the founding of the American Museum. In 1869 Mr. Green was elected a trustee of the American Museum and was appointed a member of its executive committee, on which he served until 1881. He was active not only in promoting the increasing usefulness and popularity of the institution, but also in the encouragement of research.

WE record the death of Mr. Frank Slater Daggett, director of the Museum of History, Science, and Art, of Los Angeles. Mr. Daggett spent the greater part of his life in commercial pursuits in Minnesota and Illinois. In 1911 he entered on a professional scientific career when he assumed the directorship of the newly founded museum in Los Angeles. Here he supervised the collection of important exhibits representing the natural history of southern California, and exploited scientifically the now famous asphalt deposits at Rancho-la-Brea.

Baron Gerard de Geer, professor of geology in the University of Stockholm, and Mrs. de Geer, together with Dr. R. Lidén and Docent E. Antevs, visited the American Museum on August 20. The party has come to this country to study the geological chronology since the Glacial period. Professor de Geer has worked out and applied in Europe a method of counting the seasons by the laminated clay layers annually deposited by the glaciers during the melting seasons.

The record enrollment in the United States for students of geology is announced by the University of Oklahoma. There are this year one thousand students in the department, which maintains a staff of four associate and thirteen assistant professors in addition to the head of the department. Microscopic work is being offered for the first time this year, including a special study of cuttings from oil wells provided from the Healdton, Oklahoma, oil field, through the courtesy of the Roxanna Oil Company.

An account of the drilling of our deepest wells in recent years and some of the scientific problems which they help to solve is told by Mr. Robert G. Skerrett in the *Scientific American*. The drilling of the deepest well in the world was interrupted by a cave-in far down in the hole after a depth of 7579 feet had been reached. This well, called the Lake well, was sunk in West Virginia in 1919, with the hope of reaching an oil-bearing strata of sand at 8000 feet. The second deepest well, the Goff well, is also in West Virginia, and reached 7386 feet before it was discontinued in 1918 because of the breaking of a cable; the third deepest well in the United States, the Geary well in Pennsylvania, was crushed in at 7248 feet by a water pressure of nearly 3000 pounds to the square inch. Although the boring of all these wells had to stop a few hundred feet short of the objective, it revealed a number of geologic facts of importance. The Geary well, in particular, penetrated layer after layer of rock salt below 6800 feet, showing that these strata extend in sheets of many thousand square miles as "the remains of fossil ocean water imprisoned in mid-Palæozoic time"—which may contain valuable deposits of potash salts so important for agriculture. The United States Geological Survey has investigated the problem of subterranean temperatures with specially designed apparatus in all three of these wells, recording a temperature of 168.6 degrees Fahrenheit at 7500 feet in the Lake well.

Two very important aids to the use of scientific literature on South America have recently appeared, the one a bibliography of the mineralogy and geology of Chile, the other a bibliography of the geology, mineralogy, and palæontology of the republic of Argentine.[1]

A number of minerals, of which chalcedony is the most common, have been found replacing wood, as in the noted petrified forest of Arizona. Replacement by dolomite, a common limestone mineral, has now for the first time been described[2] in a specimen from Kern County, California.

Dr. Amadeus W. Grabau, formerly professor of palæontology in Columbia University, has been appointed to a chair at the University of Peking. He will also serve as a member of the Chinese Geological Survey.

Dr. W. D. Matthew, curator of vertebrate palæontology in the American Museum, in a discussion[3] relative to discoveries of fossil vertebrates in the West Indies and the bearing of these on the origin of the Antillean fauna, concludes that the islands are not remnants of a former continent, nor have they in any likelihood been connected at any time with either of the American continents. The geologic evidence, as well as the submarine topography, is not favorable to either idea; the geology positively forbids a former connection with Florida. The islands are not very old geologically and have been built up by uplifting blocks and volcanic action. The fauna is very in-

[1] J. Brüggen, Bibliografía minera y jcolójica de Chile. *Boletin mineralógicas de la Sociedad de Mineria*, Santiago de Chile, Vol. XXXI, 1919, pp. 441–513, 539–607; Enrique Sparn, *Bibliografia de la Geologia Mineralogia y Paleontologia de la Republica Argentina*, 1900–14, Academia National de Ciencias Miscelanea: No. 2, Cordoba, 1920.

[2] *Journal of Geology*, Vol. XVIII, 1920, p. 356. By Mr. S. F. Adams, of Stanford University.

[3] *Proc. Amer. Philos. Soc.*, Vol. LVIII, 1919, p. 161.

complete and entirely insular in character and not the result of invasion from either North or South America over a supposed "land bridge." On the contrary the fauna must have arisen as the result of colonization through storms and ocean drift.

THE Bureau of Biological Survey at Washington, D. C., will in the future conduct the bird banding formerly carried on by the American Bird Banding Association under the auspices of the Linnæan Society of New York. This enterprise of placing identification bands on both water and land birds has already proved very instructive and when carried out on a large scale should give valuable information with reference to migration routes, speed, longevity, affinity for nesting sites, and behavior in general. The coöperation of volunteers throughout the country is earnestly solicited.

MR. ELIHU ROOT, speaking at this Fiftieth Anniversary Celebration of the Metropolitan Museum, expressed what civilization has long accepted as true, that the cultivation of taste is one of the mightiest agencies in the conflict between the discontent and tedium of life and happiness. We should add to this the practical dictum of Mr. Frederick Lee Ackerman, of Trowbridge and Ackerman, New York architects, who recently contributed an article to a symposium on education and art in the *Bulletin of the Metropolitan Museum*, that a true appreciation of art comes to very few except as a result of some creative experience. One key, then, to uplifting the spirit and refining the point of view of the laboring classes and advancing the happiness of all members of the race, would seem to lie in giving every student before he enters the period of self-support enough training through individual practice to provide him with an avocation in some line of art. Is it true that we must become a race of amateur artists before we can have any great output in art, any country-wide appreciation and devotion to art, or any large number of artists of the highest rank?

THE problem of opening the world's literature to the blind appears to have been finally solved through an invention by Dr. E. E. Fournier d'Albe[1] which has been constructed in a practical and commercial form by Dr. Archibald Barr, instrument maker of Glasgow. The translation of optical into acoustic effects is by way of an electric current through the metal, selenium, whose conductivity varies with the incident light intensity. An ordinary telephone receiver is attached in the selenium circuit. Luminous dots of different musical frequencies are flashed on to the printed line, letter by letter. Those dots which fall on white paper are reflected back while those which fall on the black of the type are absorbed. Each letter accordingly blots out certain notes and gives a characteristic chord while all the chords together constitute a sound alphabet which may readily be learned by most persons in a short time. The instrument as perfected by Dr. Barr can be adjusted to any ordinary printed type.

MR. JOHN BARRETT, director-general of the Pan American Union since 1907, retired from this post on September 1. He is succeeded by Dr. L. S. Rowe, formerly chief of the division of Latin American affairs of the State Department.

COLONEL W. B. GREELEY, chief of the Forest Service, returned early in September from Alaska, where he made an inspection of the Tongass National Forest. Colonel Greeley reported that the national forests of Alaska were able to supply a million and a half tons of wood pulp yearly and still keep the cut within the annual increase. The Tongass region alone can perpetually supply one half of the present news-print requirement of the United States. The government, by limiting this cut to an amount not exceeding the natural increase, will make the supply of pulp wood permanent so that manufacturers interested in the Alaskan field can count on raw material.

THE United States Forest Products Laboratory at Madison, Wisconsin, held its Decennial Celebration on July 22–23. Representatives from every wood-using industry were present. Dr. Carlisle P. Winslow, director of the laboratory, delivered an

[1] E. E. Fournier d'Albe, "The Type-reading Optophone." *Nature*, Vol. XCIV, 1914, p. 4, and "The Optophone: An Instrument for Reading by the Ear," *ibidem*, Vol. CV, 1920, p. 259.

address at the banquet in which he quoted many of the results of the work of the laboratory. Investigation on the mechanical properties of woods has permitted a 20 per cent increase in allowable working stresses in structural timbers; experiments on the proper nailing of boxes have given results which will prevent damage to commodities in shipment; experiments on water-resistant glues and plywood for airplanes saved $6,000,000 in a year for the War Department alone; investigations on the uses of hull fiber and second cut cotton linters for pulp and paper have resulted in the establishment of plants with daily capacity of 300 tons; studies in methods of turpentining have resulted in increased yields. These are only a few of the problems upon which the laboratory has been working—and, in addition, a vast field lies as yet untouched.

THE point is taken in an article in the current number of *American Forestry*, by Mr. George W. Sisson, Jr., president of the American Pulp and Paper Association, that the immediate problem in the paper and pulp question does not so much concern discovering a supply in some remote part of the continent as in promoting a supply by protection and reforestation in localities where the old established industries may be served—as in the northeastern United States. He advises as necessary, whatever policy be followed, a continent-wide coöperation looking toward economy in the use of paper among all publishers and large consumers of paper or paper products.

THE reduction of the appropriation for forest investigation by $28,728 in the Agricultural Bill which has passed Congress is nothing less than a calamity. Experiments in forestry are not matters of an hour, but require decades for completion, so that this cutting off of financial support from the Forest Service for experimentation will effect in many instances the abandonment of research work carried on for the last ten or fifteen years. The reduction will close three of the four Forest Service Experiment Stations which are located at Priest River, Idaho, at Colorado Springs, Colorado, at Flagstaff, Arizona, and at Stabler, Washington. Such a curtailment can by no means be urged on the basis of economy, for forest investigations have resulted in great saving of lumber and increase of revenue from the national domain which have repaid many times over the cost of maintenance of the stations. It will be noted that this bill carries the usual appropriation of $239,000 for the distribution of free seeds by Congressmen.

THE forest depletion of the United States and possible remedial measures are summarized in a recent circular of the Department of Agriculture.[1] More than two thirds of the primeval forests of the United States have been cut or burned over and three fifths of the timber originally in the country is gone. At present about 26 billion cubic feet are cut from the forests annually and only 6 billion grown again. This is not use of forests but their devastation. Correction of the situation can come only through restocking the 326 million acres of cut-over timber lands now standing idle. This program requires a national forest policy on a much greater scale than at present exists and also active coöperation by the several states.

Ecology, the official organ of the Ecological Society of America, calls attention to the fact that the preservation of natural areas for scientific study is of incalculable importance. One of the best ways for accomplishing this, it points out, is through coöperation with those organizations especially working for the conservation of particular regions, such as the Okefinokee Society and the Save the Redwoods League.

AN addition of 130 acres of giant Sequoias to the Roosevelt National Park has been presented to the United States Government by the National Geographic Society. When the park was established in 1916 the society supplemented the original Congressional appropriation by a gift of $20,000.

THE National Geographic Society has engaged Mr. William L. Finley, formerly state biologist of Oregon, to obtain motion pictures of the rare birds and mammals of the North American continent.

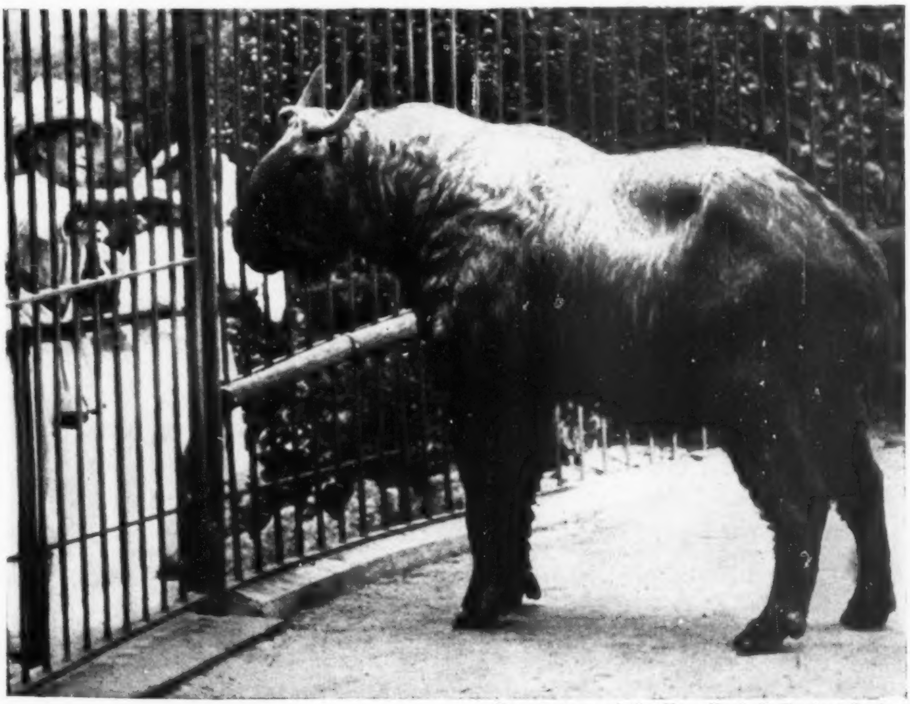
DR. E. W. NELSON, chief of the Biological Survey, has spent several months recently in

[1] "Timber Depletion and the Answer." *Department Circular* 112, United States Department of Agriculture, 1920.

Alaska for a study of fur-bearing animals and of the salmon industry. Improvement of the reindeer herds as a source of meat, fox farming, and the protection of the land fur-bearing animals have been assigned to the United States Department of Agriculture, and a permanent staff for these duties will be established in Alaska.

THE *Statement of the Permanent Wild Life Protection Fund* for 1917, 1918, and 1919, has been issued by Dr. William T. Hornaday, director of the New York Zoölogical Park and campaigning trustee of the fund. The volume includes a special collection of illustrated campaign reports and papers on various features of conservation. This permanent fund, founded by gifts from Mrs. Russell Sage and other public-spirited persons, has now extended its activities beyond the shores of North America, especially into France and Belgium, where it has been engaged in promoting the protection of food crops. The chief activities in North America, other than the campaign for protection of the grouse, have been the promotion of legislation such as the game sanctuary bill and the migratory bird treaty, aid in the creation of 6468 wild life sanctuaries, contribution to game utilization in Canada, and opposition to the sale of seized plumage.

A LARGE shipment of animals from Africa has arrived in the United States and has been distributed among the New York, Philadelphia, and National zoölogical parks. The safe arrival of the shipment was made possible largely through the energetic coöperation of the director of the National Zoölogical Garden of South Africa at Pretoria, Mr. A. K. Haagner, who personally



By courtesy of the New York Zoölogical Society

This Bhutan takin (*Budorcas taxicolor*), for ten years past a resident of the London Zoölogical Garden, was a representative of the most southern of the three known species of this genus of Asiatic ruminants. Toward the South the species become successively darker in color and shorter-haired; that inhabiting Assam Valley, India, and Bhutan is chocolate-brown with black underparts; the Chinese takin discovered by Mr. Anderson in the Province of Shensi, central China (see page 428), is of uniform golden yellow; the Tibetan takin of Szechwan, southwestern China, shows an intermediate hue. The animals are about the size of our domestic cattle and are heavily built, yet they range over the rocky sides of high mountains with unusual nimbleness. In climbing precipitous slopes they are possibly aided by the two false hoofs of each foot, which are apparently functional

brought the collection to America. The most valuable specimen is a Nubian giraffe, ten feet high. Among the other species of large mammals are included the nearly extinct mountain zebra, sable and lechwe antelopes, gemsbok, eland, gnu, springbok, blesbok, and Chapman zebra. Three individuals of a new species of Rhodesian baboon were the special gift of Mr. Haagner. In return, the New York and Philadelphia zoölogical parks are planning to ship to Africa a representative collection of American animals.

IN a recent illustrated pamphlet[1] by Mr. Ned Dearborn, of the United States Biological Survey, a definite stand is taken for the protection of the North American small mammal fauna, outside of the recognized pests, rabbits, rats, and mice. Fortunately, the advice given is likely to be followed the country over because of the enhanced market value of all kinds of fur. The different species in themselves are for the most part valuable because they help rid the country of insect and rodent pests, or, if vegetable feeders, are at least negative in effect because not feeding on cultivated crops—and as fur bearers they put "millions of dollars a year into the pockets" of the Americans who trap them.

The species considered in the pamphlet, with statement of food, the best season for trapping, directions for construction of traps, and for preparation of the skins for market, are more than a dozen in number. Among them are the striped skunk, the little spotted skunk or "civet cat," mink, weasel or "ermine," otter, the different kinds of foxes, mole, muskrat, and beaver. The amount of American-grown raw fur available for the markets has decreased, it is said, from 25 to 50 per cent in the last ten years. Our great fur sales of today must be stocked from all parts of the world, and manufactured furs in 1919 brought prices 200 per cent higher than they did two or three years back. Mr. Dearborn, who has spent many years on this particular problem of investigation, gives specific constructive advice relative to the conservation of fur-bearing species and the permanent improvement of America's wild fur.

[1] Separate No. 823, reprinted from the *Yearbook* of the United States Department of Agriculture, 1919.

DR. JAMES WILSON, secretary of agriculture during the administrations of President McKinley, President Roosevelt, and President Taft (1897–1913) and previously professor of agriculture in Iowa Agricultural College, died on August 26.

DR. RODNEY H. TRUE, who has had charge of physiological investigations in the United States Department of Agriculture, has resigned from the department to accept the chair of botany in the University of Pennsylvania.

THE Crop Protection Institute, a coöperative group of investigators of insect pests and plant diseases and representatives of companies manufacturing poisons used in fighting these destructive agents, has been organized with the assistance of the National Research Council. Mr. Harrison E. Howe, chairman of the Division of Research Extension of the Council, is temporary secretary.

Two new magazines in the field of archæology and anthropology have been inaugurated in Mexico. *El Mexico Antiguo*, under the editorship of Herman Beyer, is devoted to the archæology, ethnology, folk-lore, prehistory, ancient history, and linguistics of that country; *Ethnos* will appear as a monthly review of the anthropological sciences in Mexico and Central America. The editor of the latter, Manuel Gamio, is director of the division of anthropology in the Department of Agriculture. He is widely known as the author of general works on the development of Mexico and Latin America.

THE sources and authenticity of the history of the ancient Mexicans as revealed by the surviving pictographic codices and maps are the subject of a recent monograph.[2] Several of these Mexican documents antedate the Spanish Conquest and recount the ancient migrations (probably from southwestern United States), the subjection of Mexico, and the founding of the Aztec Empire. Dr. Radin discusses the degree of reliance with which these records may be accepted and concludes that they should yield a fair account of Nahuan and Aztec history from at least about 1109 A.D. There

[2] *University of California Publications in American Archæology and Ethnology*, Vol. XVII, No. 1, 1920, pp. 1–150. By Dr. Paul Radin.

is great need for a critical edition of all these ancient sources and for a search for undiscovered codices that undoubtedly lie forgotten in some of the older libraries of Europe. Dr. Radin reproduces in part the oldest known codex, the *Codex Boturini*, and several of the maps, and gives translations of certain of the commentaries.

THE application of anthropological methods to tribal development in New Guinea (Papua) is presented [1] by Lieutenant E. W. P. Chinnery, formerly acting resident magistrate in the Delta Division of Papua. The problem is one of universal application, namely, how to stabilize primitive institutions so that the development of the culture of a savage people can proceed by way of something tangible to a higher plane of moral and social ideals. For this it is necessary to uphold the indigenous culture except where it conflicts with these moral and social ideals. The most difficult savage custom with which a government has to deal is homicide in its various forms such as head-hunting and cannibalism. Among some tribes in Papua killing a man was a necessary accomplishment before a male could become an adult member of his tribe. "If homicide," says Lieutenant Chinnery, "be an essential link binding together the social and religious fabric of a community, the suppression of homicide is likely to result in the collapse of the whole structure unless something equally capable of perpetuating tribal welfare is substituted to fill the void." Such a substitution, successfully accomplished, is narrated in the case of a tribe which had been in a state of disaffection for nearly five years due to the presence of a government station which prevented initiation of its youth, by prohibiting homicide. It was finally decided by the chiefs that the essential element in the custom that a youth must kill a man before he became eligible for initiation, was the demonstration of courage, which could be just as well proved by the killing of a wild boar. The result of this compromise was highly satisfactory to both the natives and the government. "My experience in Papua," concludes Lieutenant Chinnery, "has convinced me that only by developing the natives and their cultural institutions together can we hope to give them a civilization more beneficial than the primitive life from which we intend to lead them."

[1] E. W. P. Chinnery, "The Application of Anthropological Methods to Tribal Development in New Guinea." *Journal of the Royal Anthropological Institute*, Vol. XLIX, 1919, p. 36.

DR. CLARK WISSLER, curator of anthropology in the American Museum and president of the American Anthropological Association, has pointed out in a paper on "Opportunities for Coördination in Anthropological and Psychological Research" [2] how the two sciences are differentiated. The one is concerned with the mental processes of the individual while the other studies races and cultures as group phenomena. Points of contact between the two sciences, however, are multiform, for an understanding of the group presupposes knowledge of its elements, and in a study of the individual one must consider the social conditions within which he moves. A concrete example of a problem in the solution of which joint psychological and anthropological "engineering" would find a place is presented by the program of Americanization in which the country is at present interested. This program involves many subsidiary problems, some psychological, some anthropological, such as the identification of racial characters, the inheritance of morphological and mental traits, the effect of environment upon individual development, and the psychological factors of cultural change. Applied psychology has been for many years a study fundamental to the science of pedagogy and it is now apparently finding a place in industrial management. The day of the anthropological engineer is just dawning, but he has already made a beginning in the handling and training of various foreign labor groups. "The hope of mankind is that science will point the way to correct procedure even in matters of education and social adjustment. The power of science, when its efforts are coördinated, was clearly demonstrated during the war. It needs no defense now. It is for psychology and anthropology to live up to the reputation of science as a whole."

MR. SYLVANUS G. MORLEY returned to Washington in July after an absence of several months in Central America, where he has been in charge of the Carnegie Institution expeditions.

[2] *American Anthropologist*. Vol. XXII, 1920.

The work of Mr. Louis R. Sullivan in the Southern Pacific will give the American Museum a good racial exhibit of Hawaii as a type for Polynesia. The ethnological studies of the American Museum in coöperation with the Bishop Museum of Honolulu under the direction of Mr. Sullivan will include a comprehensive survey of all the peoples of the Hawaiian Islands. Special attention will be given to Hawaiians of pure blood and of mixed blood.

Evidence of a crude practice of surgery, involving the support of a fractured arm by wooden splints, has been brought to light by a recent excavation at the Pueblo ruin at Aztec, New Mexico. The skeleton is that of a girl of about twenty years, who had suffered a severe injury, fracturing the left forearm and the hip. The latter was apparently beyond the primitive surgeon's skill, but the forearm was surrounded with wooden splints, well shaped and carefully bound in position.

The Sixth International Sanitary Conference of the American Republics will meet December 12–20 in Montevideo, Uruguay, under the presidency of Dr. E. Fernandez Espiro. This Pan American Congress will discuss important problems of public hygiene, sanitary law, and epidemic diseases.

Dr. Frederic S. Lee, professor of physiology in Columbia University, and Dr. Graham Lusk, professor of physiology in Cornell University Medical College, have been elected members of the board of the Institut Marey, a physiological institute in Paris.

That the subepithelial collections of lymphoid tissue found in the tonsils, adenoids, vermiform appendix, and elsewhere in the body, are not useless vestigial relics which should be removed at the least excuse, but are glands which play an important part in immunizing the body against pathogenic bacteria has been maintained by Dr. K. H. Digby.[1] These glands are continually ingesting bacteria and so producing natural immunity after the manner of inoculation for artificial immunity. They bear the brunt of the attack in infections such as scarlet fever, typhoid fever, and appendicitis, and in some cases diseases may be entirely localized in these glands so that the patient apparently secures immunity through mere exposure or a mild attack, as of tonsilitis. A more recent experiment [2] on the regeneration of the appendix of the rabbit tends further to show that that organ plays some important rôle in the economy of the organism. After amputation of the rabbit's appendix the terminal portion of the cæcum generates a new appendix histologically and physiologically similar to the normal organ.

The death-rate from tuberculosis, declining at an accelerated rate, has dropped nearly 60 per cent since 1865 so that there is definite hope that the disease is dying out. Dr. Louis Cobbett, lecturer in pathology at the University of Cambridge, summarizes the situation in a recent issue of *Discovery* comparing the decline of tuberculosis to the disappearance of leprosy which was at one time a common scourge, but is now practically extinct in the western world. The cause of the decline of tuberculosis, according to Dr. Cobbett, is the "amelioration of social conditions" through decrease of overcrowding, politer manners, more and better food, and the "cult of the open window." The World War has set back the victory over tuberculosis probably more than fourteen years in England. On the Continent, especially in Austria where semistarvation has prevailed, tuberculosis has run riot.

Mr. W. J. Matheson, president of the biological laboratory at Cold Spring Harbor of the Brooklyn Institute and scientific adviser in chemistry to the Board of Health for the city of New York, has received the honorary degree of doctor of laws from the University of St. Andrews, Scotland.

Mr. Arthur J. Jacot, who for two years has been engaged in cataloguing the mollusk collections of the American Museum, left the museum in August to teach biology in the North China Language School, Peking.

The artificial propagation of oysters has hitherto proved impossible through inability to change the water without losing the microscopic young. Mr. W. F. Wells, biologist

[1] *Immunity in Health.* The Function of the Tonsils and Other Subepithelial Lymphatic Glands in the Bodily Economy. Oxford University Press, 1919.

[2] *Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences*, Tome 170, No. 16 (19 Avril 1920), p. 960.

of the New York State Conservation Commission, has overcome this difficulty by using a centrifugal machine which concentrates the millions of minute forms sufficiently to allow transference to a fresh supply of water. He has thus made possible the maintenance of the animals until they have "set" or attached themselves to available objects, whereupon they can be handled and moved to suitable growing grounds. This puts oyster culture on a par with the now widely used fish culture.

A COLLECTION of fishes, representing species especially valuable for study, was secured in Hawaii for the American Museum by Dr. B. W. Evermann, director of the Museum of the California Academy of Sciences, while in attendance at the Pan-Pacific Congress.

DR. HIKOSHICHIRO MATSUMOTA, assistant professor of palæontology in the Northeastern Imperial University, Japan, is making his headquarters at the American Museum while on a visit of several months to the United States. Professor Matsumota, who has previously published several papers on Pleistocene and later Tertiary mammals and reptiles of Japan and China, is now engaged in studying the prehistoric human remains of Japan.

THE bust in bronze of John Muir, a halftone reproduction of which appeared in the March-April number of NATURAL HISTORY, was presented to the American Museum by Mrs. E. H. Harriman. The bust was modeled by Miss Malvina C. Hoffman, a well-known American sculptor, pupil of Rodin and of Borglum. She has exhibited her work frequently both in this country and abroad and received first honorable mention in the Salon, Paris, in 1910–11.

ON October 27 the sixty-second anniversary of the birth of Theodore Roosevelt was commemorated beside his grave at Oyster Bay. Among the organizations sending representatives were the New York Botanical Garden, the Torrey Botanical Club, the New York Horticultural Society, the American Museum of Natural History, the National Association of Audubon Societies, the American Scenic and Historic Preservation Society, the Brooklyn Institute of Arts and Sciences, and the New York Bird and Tree Club.

MR. SHOW SHIMOTORI, one of the ablest artists on the staff of the American Museum, has returned to Japan on an extended leave of absence. For the last eleven years Mr. Shimotori has been associated with the department of invertebrate zoölogy as one of a corps of skilled artists and modelers engaged in preparing the series of "window groups" in process of installation under the direction of Mr. Roy W. Miner. In this work Mr. Shimotori is responsible for the remarkably accurate and artistic coloring of the thousands of models of sea animals and plants comprising these groups, but the character of his work is particularly well shown in the realistic coloring of the transparent backgrounds which form part of the setting. In some cases these are photographs on glass which he has colored by hand. In others, an unusual submarine effect has been produced by coloring on successive sheets of plate glass in such a way that when placed one before the other, the whole is blended into one composition. The work of Mr. Shimotori was not confined to the laboratory; he accompanied many of the department's expeditions, and his work as field artist called for adaptability and versatility as well as artistic skill.

Now that the New York Aquarium has a collecting boat, the "Sea Horse," which explores the salt waters of this neighborhood, the American Museum's department of ichthyology through friendly coöperation will learn many new facts about the movements of marine fishes.

MR. JULIAN A. DIMOCK has been elected a patron of the American Museum in recognition of his gift of 3874 photographic negatives, including large series on many natural history subjects.

DR. W. D. MATTHEW, curator of vertebrate palæontology in the American Museum, New York, left in August for a visit to the museums of Europe. He expects to return some time in December.

THE preservation of inland lakes and marshes in the interest of bird conservation in lieu of their indiscriminate drainage is recommended by Dr. E. W. Nelson, chief of the Biological Survey. The perpetuation of inland lakes and inland and coastal marshes is necessary to provide feeding and

resting places for our migratory wild fowl. Even from the economic standpoint these lands probably, under proper protection, would prove of more value to the community in the game they yield than as agricultural lands.

THE American Museum has long maintained a special collection of the birds found within fifty miles of New York City, grouped together in a separate exhibit. In connection with this local group is arranged monthly a seasonal display containing only those birds which may be expected during the current month. This gives a sort of picture of the bird life of the month and facilitates the identification of any recently observed bird. Dr. Frank M. Chapman, curator of birds in the American Museum, has incorporated this scheme in book form [1] with the aid of 301 drawings in color by Mr. Edmund J. Sawyer. A cabinet of drawings is arranged so as to show in groups the permanent residents, winter visitors, and spring migrants of the northern and southern sections of the eastern United States. On any one plate the birds are drawn to the same scale, so that their relative sizes are apparent, a feature which is an important aid in identification. To these drawings are added 134 pages of what Dr. Chapman calls "labels," giving briefly the distinctive characteristics, habits, and range of each.

[1] *What Bird is That?* A Pocket Museum of the Land Birds of the Eastern United States Arranged According to Season. New York and London, 1920.

SINCE the last issue of NATURAL HISTORY the following persons have been elected members of the American Museum:

Patron, JULIAN A. DIMOCK.

Fellow, GEORGE W. KORPER.

Life Members, MESDAMES HELEN A. BELL, HENRY D. PRESCOTT, THE HONORABLE MCDOUGALL HAWKES, MESSRS. SIMON A. ALCAIDE, SYDNEY BEVIN, VICTOR D. BEVIN, WM. NELSON CROMWELL, WEBB FLOYD, and JOHN MARSHALL.

Annual Members, MESDAMES PAULINE BOETTGER, C. F. BOKER, DUDLEY BUCK, ROBERT W. COLLINS, BAYARD DOMINICK, RICHARD A. DORMAN, A. J. FOX, M. J. KAUFMANN, R. S. KELLOGG, J. P. KNIGHT, JR., MISSES C. HOSKINS-MINER, MATILDA J. MCKEOWN, AUGUSTA N. TOMPKINS, LOUISE F. WICKHAM, DOCTORS J. GEIGER, BERNHARD W. WEINBERGER, G. H. ZIMMERMAN, MESSRS. THOMAS H. ALISON, WALTER BAUER, LOUIS BEERMAN, WILLIAM BLUMSTEIN, FREDERICK BROOKS, A. J. BROSSEAU, NAT. I. BROWN, F. H. BROWNELL, WALTER BUCKNER, HARRY CAPLIN, WALTER M. CARLEBACH, J. MAXWELL CARRERE, GEO. L. CONNOR, R. CLARENCE DORSETT, HENRY DUNKAK, RALPH ELLIS, GEO. W. ENGLISH, ERLAND F. FISH, PELL W. FOSTER, LAWRENCE D. FRANK, JACOB L. FRANKEL, W. FRAZER GIBSON, M. GLAUBER, HENRY W. GORDON, B. GUGGENHEIM, ARTHUR B. HATCHER, CHARLES E. HEYMANN, L. G. HORST, ALBERT G. KAUPE, HENRY G. F. LAUTEN, EDWIN LUDLOW, JOHN EMERY MCLEAN, EDWIN W. MERRIAM, GEO. W. OCHS OAKES, JESÚS SASCORTS, MARKIAN STANKO, HARRY WACKER, CHESTER W. WASHBURNE, and CHARLES WISNER.

Associate Members, MESDAMES VINNIE R. ABORN, R. G. AITKEN, A. A. CRANE, ELLERY DAVIS, MARY K. PETERS, MISS JOSEPHINE KELLY, DOCTORS T. M. ADERHOLD, IRA AYER, IDA BARNEY, ROBERT A. BLACK, G. W. BOOT, D. C. BRYANT, J. E. CHACE, M. A. CLARK, T. SHIELDS COLLINS, JAMES E. CONNETT, LAURENCE F. CUSICK, DAVID J. DAVIS, HENRY H. DONALDSON, CHARLES A. ERDMANN, JAMES S. FOOT, R. B. GIFFEN, T. CASPAR GILCHRIST, JOHN M. GILE, C. H. GURNEY, E. W. MONTGOMERY, PROFESSORS WILLIAM DODGE FROST, RUFUS LOT GREEN, HERBERT OSBORN, MESSRS. DUFF A. ABRAMS, DEAN BABCOCK, MALCOLM H. BISSELL, CHARLES S. BOYER, PETER A. BRANNON, JOSEPH A. BRAZA, FRANK H. BREWSTER, C. T. BROWN, GEORGE BURNHAM, JR., WILLIAM PHILLIPS CAINE, THOMAS K. CHAMBERLAIN, ROLLIN L. CHARLES, SANFORD L. CLUETT, ALBERT H. CROSBY, W. H. DALTON, R. P. DOW, JAMES H. DUNCAN, SAMUEL L. EARLE, ROBERT J. FISHER, JOHN F. FITZPATRICK, ARTHUR DE WINT FOOTE, FREDERICK EUGENE FOWLE, MAURAN I. FURBISH, THOMAS S. GATES, JOHN GROSS, JAMES COFFEE HARRIS, PAUL B. HAVILAND, A. P. HENDRICKSON, GEORGE WM. HILL, CHARLES F. HILLS, CHAS. A. HUGHES, JOHN H. JONES, DELACOURT KELL, W. S. KILTON, BYRON LEAIRD, JOHN C. MARKEY, WILSON W. MILLS, PAUL N. MYERS, JOHN MILTON OLIVER, JOHN H. PACKARD, W. W. WALLACE, ALAIN C. WHITE, WM. HENRY WHITE, HARRIS WHITTEMORE, and MASTER NALBRO FRAZIER.